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**WATERSHED WORK PLAN
MONTPELIER CREEK WATERSHED
BEAR LAKE COUNTY, IDAHO**

February, 1964



IDAHO

Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public law 566, 83rd. Congress, 68 Stat. 666) as amended.

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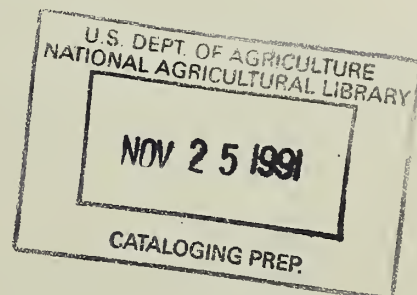
WATERSHED WORK PLAN

MONTPELIER CREEK WATERSHED

BEAR LAKE COUTY, IDAHO

Prepared under the Authority of the Watershed
Protection and Flood Prevention Act (PL-566)
83rd Congress, 68 Stat. 666) as amended.

Prepared by: Bear Lake Soil Conservation District
Montpelier Irrigation Company
City of Montpelier



with assistance by:

U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, Forest Service
U. S. Department of Agriculture, Farmers Home Administration
U. S. Department of Agriculture, Agricultural Stabilization
and Conservation Service
U. S. Department of Interior, Bureau of Land Management
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State of Idaho, Cooperative Extension Service
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State of Idaho, State Board of Land Commissioners
State Land Department
State Forestry Department

February, 1964

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WATERSHED WORK PLAN
MONTPELIER CREEK WATERSHED

Bear Lake County, Idaho

February, 1964

SUMMARY OF THE PLAN

The Montpelier Creek Watershed is located in Southeastern Bear Lake County, Idaho. It consists of 51,600 acres in the Bear River Drainage.

The Work Plan was prepared by the Bear Lake Soil Conservation District, Montpelier Irrigation Company and the City of Montpelier.

Watershed Problems

Montpelier Creek has a history of damaging floods which have caused flood-water and sediment damage to the City of Montpelier, Federal and State highways, railroad, irrigated agricultural lands and irrigation water distribution systems. Floods are from two types of events namely: (1) the winter event which occurs in February or March and is caused by rapid snowmelt usually accompanied by rain on frozen lower elevation lands in the watershed; (2) the spring event caused by abnormal rate of snowmelt from principal water producing areas.

Agricultural water management problems include deficiency of late season irrigation water, management of present irrigation water supply and renovation of high water table lands. Progress in the application of agricultural water management structural and land treatment measures has been slow because of the constant hazard of flooding as well as the shortage of mid and late season irrigation water supplies.

Erosion and depletion of forage resources on Federal, State and private lands plus the need for stabilization of critical floodwater and sediment source areas in the upper watershed lands are other problems that need prompt attention.

Sediment derived from overland flow from dryland farming areas and deposited in the irrigation distribution system and on adjoining irrigated cropland areas constitutes a major sediment problem.

Measures to be Installed

Works of improvement included in the plan are designed to improve the irrigation distribution system and raise on-farm irrigation efficiencies, reduce flood water and sediment damage to city and adjacent agricultural properties, improve the productive capacity of irrigated land, restore productivity and halt erosion on range and dry farm lands.

The estimated installation cost of the works of improvement included in the work plan is \$2,379,683. The Federal share (P.L. 566 funds) will be \$1,455,525. Share of costs to be paid from other funds is \$924,158. The work plan installation period is eight years.

Land Treatment Measures

Land treatment measures included in the plan are necessary to achieve the desired level of conservation development and effective operation of the structural measures. These measures to be installed can be grouped into the following general categories:

1. Measures to be installed on critical floodwater and sediment source areas located in the higher elevations that will reduce damage to structures and agricultural and urban areas downstream.
2. Measures to be installed on the intermediate range land areas that will reduce sediment production and reduce the deterioration of the vegetal cover.
3. Measures to be applied to dry croplands that will reduce sediment production and floodwater erosion and will halt the land deterioration currently underway.
4. Measures to be applied to irrigated valley lands to increase farm irrigation efficiencies, soil fertility, crop yields and generally improve the agricultural economy of this rural community.

The total installation cost of all land treatment measures is estimated to be \$737,008 of which \$188,625 or 26% will be from P.L. 566 funds and \$548,383 or 74% will be from other funds. Technical assistance for accelerated land treatment costs on non-Federal lands will be borne by P.L. 566 funds.

Structural Measures

Structural measures included in the plan will provide flood protection to agricultural lands and the City of Montpelier, provide for more efficient use of the water supply, increase amount of water available for mid and late season use, and supplement the land treatment program in reducing erosion, sediment and flood damage.

Structural measures include: a multiple-purpose reservoir on Montpelier Creek, a multiple-purpose canal north and east of the City of Montpelier, a multiple-purpose drain north of the city, a diversion channel to dispose of floodwater from Joe's Gap, a stream channel improvement through the City

of Montpelier, a debris basin on a side drainage south of the city, and an irrigation canal south of the city.

The total installation cost for structural measures is \$1,642,675 of which \$937,850 is for flood prevention, and \$704,825 for agricultural water management. Public Law 566 funds will bear \$870,985 and other funds will bear \$66,865 of the installation cost for flood prevention structural measures. Public Law 566 funds will bear \$395,915 and other funds will bear \$308,910 of the installation cost for agricultural water management. The installation costs include land rights, water rights, and contract administration, all of which will be borne by non-Federal funds.

Benefits, Damage Reductions and Costs

Total annual flood prevention benefits from the structural measures will amount to \$69,296. This includes \$37,100 in benefits from reduction of flood damage and \$32,196 in benefits from more intensive land use. Land treatment measures on critical flood source areas will produce an additional \$1,210 annually in flood damage reduction benefits.

Annual Agricultural Water Management benefits from the structural measures will total \$42,768. This includes \$36,575 benefits from irrigation and \$6,193 from drainage.

Annual incidental recreation benefits will total \$6,500.

Total average annual benefits from the structural measures will be \$118,564 and the annual cost of installing and maintaining these measures will be \$64,645. Overall ratio of benefits to costs of all structures is 1.8:1. Secondary benefits have not been evaluated or used in the project justification.

Project Installation and Financing

Sponsoring organizations will acquire necessary land easements and rights-of-way, water rights, execute agreements with owners of private lands for installation of the land treatment measures, and provide the non-Federal share of the installation cost for project measures. Sponsoring organizations will contract for construction of the structural measures in the plan. Funds for payment of the non-Federal share of the installation costs, including repayment of the proposed F.H.A. loan by the Montpelier Irrigation Company, will be provided through assessments of Irrigation Company stock, taxing authority of the City of Montpelier and contractual arrangements by the sponsors and water users. Legal authority for contractual arrangements by the sponsors is adequate to meet their financial responsibilities.

Operation and Maintenance

Annual operation and maintenance costs for structural measures are estimated to be \$12,655. These costs will be shared by the Montpelier Irrigation Company and the City of Montpelier. Specific responsibilities are outlined under the "Provisions for Operation and Maintenance" section of the Work Plan.

Land treatment measures installed on non-Federal lands will be operated and maintained by owners and operators under agreement with the Bear Lake Soil Conservation District.

Maintenance costs after the installation period for land treatment measures to be installed on National Forest Lands will be borne from funds appropriated to the Forest Service.

DESCRIPTION OF THE WATERSHED

Physical Data

The Montpelier Creek Watershed is located in Southeastern Idaho in the southeastern part of Bear Lake County. The watershed covers approximately 51,600 acres and is 16-18 miles long and 5 to 7 miles wide. The incorporated City of Montpelier, with a population of 3,250, is the only community in the watershed.

The Bear River forms the west boundary of the watershed. The drainage divide of Montpelier Creek, plus tributary drainages of Home Canyon and the South Fork of Montpelier Creek, comprise the east, north and southern boundaries of the watershed area.

Montpelier Creek is a tributary of the Bear River. It drains the entire watershed except for the low lying foothills commonly called the Montpelier Frontal Area. Montpelier Creek is fed by snowmelt with the principal runoff occurring during late spring and early summer.

Elevations in the watershed range from 9,390 feet in the mountainous upper watershed to 5,914 feet on the Bear River. The City of Montpelier lies at an elevation of 5,963 feet above sea level. The upper watershed is formed of steep rocky foothills and mountains primarily used for grazing, recreation, wildlife and watershed purposes. The bench and valley lands consist of sloping flood plains with moderately to steeply sloping fans and benches located adjacent to the mountain face. Dry farm lands are generally located between elevations 6,000-6,500 feet and irrigated lands below 6,000 feet.

Montpelier Creek is the principal source of irrigation water in the watershed. It also furnishes municipal, culinary and livestock water.

The Montpelier Irrigation Company is the principal company distributing irrigation water in the watershed. No storage reservoirs are included in the present irrigation system.

During the months of July and August most of the irrigated lands experience a severe water shortage. In extreme water shortage years 75% of the area suffers some type of crop failure because of inadequate water supplies.

Average annual precipitation in the irrigated areas adjacent to Montpelier is 13.5 inches with less than 40% falling during the May-September growing season. Precipitation increases with elevation to more than 30 inches at 9,000 feet.

The average annual frost free period at Montpelier is from June 9 - September 9. Late spring and early fall frosts occasionally affect crop production.

Soils

Soils in the irrigated area are well drained, medium to moderately fine textured, generally more than 36 inches deep. Moisture holding capacity is

2 - 2.2 inches per foot depth of soil. There are areas of gravelly soils intermixed with the deep soils. These soils are shallower and are located over gravel or bedrock at 20 - 36 inches depth. Moisture holding capacity is 1.7 to 2.0 inches per foot depth of soil. The underlying gravelly material will hold .5 - 1.5 inches of moisture per foot depth. Some locations have a strong lime accumulation in the lower part of the soil or the upper part of the gravel. There are also some soils that are deep, imperfectly and poorly drained with moderately coarse to moderately fine textures. These soils have a moderate salinity and have slopes generally from 0 - 2%.

Dryland soils are well drained, medium to moderately fine textured, more than 36 inches deep. Moisture holding capacity is 2 - 2.2 inches per foot depth of soil. Some of the soils are shallower being 20 - 36 inches deep over gravel or bedrock. Moisture holding capacity is 1.7 to 2.0 inches per foot of depth of soil. The underlying gravelly material will hold .5 - 1.5 inches of moisture per foot depth. Slopes for the dryland soils vary from 0 - 20%.

Range land soils are predominately shallow and stony with exposures principally to the south and west. Slopes are cut by secondary drainages that break the terrain and results in the inclusion of small segments of steep north and east slopes. Climatic conditions for these areas are more favorable than the dominant slopes and usually support a fairly good ground cover of grasses and forbs and a fairly good overstory of low trees and shrubs. Principal range sites in the watershed are shallow stony south slope, shallow stony north slope, loamy upland, stony upland, gravelly upland and creek bottom. Soil texture for the first four range sites listed above are classified as loams, silt loams and clay loams while the texture for the gravelly upland site is a gravelly silty clay loam and the creek bottom a silty clay loam.

Economic Data

The population of the Montpelier Creek Watershed is estimated to be 3,325. Most of the people reside in the town of Montpelier, including many of the farm owners and operators.

Montpelier was settled in 1864 and the first irrigation system was constructed the same year. Population increased from the date of settlement up to the early 1900's. Since 1920 there has been a gradual decline in population resulting from decreased employment opportunities on the farm and the absence of industrial development. Many of the young people are forced to leave to find employment elsewhere. As a result, the work force of this community is older than the national average.

In 1955 a plant to process phosphate rock was constructed in a neighboring community. The resulting increase in labor opportunity has tended to stabilize the population in the area.

The agricultural economy is based on 15,107 acres of private land which is used in conjunction with the public land in the national forest and national land reserves located in the watershed and the adjoining areas. About 6,935 acres are irrigated and 2,400 acres are farmed as dry land. The 4,662 acres of range land in private ownership are used in conjunction with

public range land areas. It is estimated that 1,110 acres are used for urban and miscellaneous purposes.

LAND OWNERSHIP

Owner	Acres	Percent of Total
Private	15,107	28
Public, Federal		
National Forest	34,133	67
National Land Reserve	480	1
Public, Non-Federal		
State of Idaho	1,880	4
<hr/>		
Total	51,600	100%

LAND USE - PRIVATE LAND

Use	Acres	Percent
Irrigated Cropland	6,935	47
Dry Farm Land	2,400	16
Range Land	4,662	30
Urban and Miscellaneous	1,110	7
<hr/>		
Total	15,107	100%

The agriculture consists primarily of the production of small grains and alfalfa hay used in the livestock enterprises. Some of the wheat produced is sold as a cash crop. The percentages of the principal crops grown on the irrigated land are: barley, 27%; alfalfa hay, 24%; pasture, 46%; and 3% is wheat and oats. The non-irrigated cropland is used for the production of wheat and barley in a small grain-summer fallow rotation. Wheat makes up about 30% of the acreage in crop while barley is grown on about 15%. About 55% of the area is in summer fallow each year.

The watershed has 63 farms averaging 222 acres. The largest farm operation in the watershed contains 500 acres of cropland. The amount of irrigated land per farm varies from 10 to 260 acres, averaging 110 acres. Of the total 63 farms in the watershed, 50 of them receive water from the irrigation company system. The average number of acres irrigated per farm from the system will be 68 acres. Several of these farms also have sub-irrigated land. Most of the 13 farms not receiving water from the irrigation company system have lands which are either sub-irrigated or are irrigated by private sprinkler systems.

In the area receiving water from the irrigation company the average size of the full time family farm operation is 200 acres. In most cases the farmer owns one or more farms and leases one or more additional farms. The operation consists of approximately 69% irrigated cropland, and 31% in hay and pasture. Most of the farms below 150 acres in size are either leased or farmed on a part-time basis.

The principal agricultural products are shipped from the watershed by truck and rail. Livestock are shipped mostly by truck to Ogden, Utah or to Pocatello, Idaho. Most of the grain is shipped by rail. The area is served by U. S. Highways 89 and 30N and by the Union Pacific Railroad.

There are 34,133 acres of national forest land within the boundary of Caribou National Forest located along the north, east, and south boundary of the watershed. Privately owned land consisting of 15,107 acres is generally located in the southwestern portion of the watershed. Interspersed within the national forest and private lands are 1,880 acres of state land and 480 acres in the national land reserves, administered by the Bureau of Land Management. Public lands are important as they furnish summer grazing for livestock and recreational opportunities and are an integral part of the agricultural economy.

State grazing lands lying within the boundaries of the Caribou National Forest are managed cooperatively by agreement with the Forest Service.

The recreational opportunities, generally located on public lands, play a big role in the economy of Montpelier. Montpelier Creek is an important weekend camping and fishing area. During the summer months a high percentage of the campers come from as far away as Salt Lake City, Utah. Most of the present forest camping facilities are used to capacity every weekend during the summer. Tourists bring considerable trade to the businessmen of Montpelier. The ratio of out of state fishing licenses sold in Montpelier to residential licenses is among the highest in the state. The local rod and gun club constructed a fish rearing pond on the South Fork of Montpelier Creek in 1946 to enable the Idaho Fish and Game Department to rear fingerlings to legal size for planting in the stream. The pond has enabled the state to improve the fishing in Montpelier Creek without spending any additional state funds. The net result of the local rod and gun club program has been an increase in the number of non-residential recreational visits which has increased the flow of outside money into the area.

WATERSHED PROBLEMS

Major problems in the Montpelier Creek Watershed include:

1. Floodwater and sediment damage to the City of Montpelier, to the irrigation distribution system, to highways and the railroad and to the irrigated lands.
2. A deficiency in the supply of late season irrigation water and the need for improving the application of irrigation water, also there is a need to lower the high water table on certain lands through improved drainage.
3. Stabilization of unstable critical flood water and sediment source areas in upper watershed lands.
4. Erosion damage and depletion of forage resource on National Forest, private and state lands.

Flood Problems

The City of Montpelier, and the adjacent agricultural area, are subject to flooding from Montpelier Creek by two types of floods, namely, winter and spring floods. The winter flood is caused by rapid snowmelt accompanied by rain on the lower parts of the watershed, which results from the flow of warm moist air into the region during the normal cold season and cannot be forecast except that it is usually accompanied by a dense frost layer in the soil during the previous fall and winter. The spring type flood is caused by abnormal rate of snowmelt from the snow pack on the main part of the watershed during the spring warm-up and its magnitude can be forecast with some accuracy from snow survey data.

There is also a difference in the damages caused by the two types of flood. Water from the winter flood on Montpelier Creek is usually fairly clean and damage in town is principally by water damage to houses and residential property. In some instances a relatively small flood flow can cause extensive damage where ice, which has formed from the small steady flow of the creek during the winter, breaks loose causing the creek to overflow. The winter flood run-off from the frontal areas on the other hand often carries large amounts of sediment which is deposited in the irrigation canals and on adjacent irrigated cropland. Water from the winter floods also accumulates on fields which have poor surface drainage where it freezes into a sheet of ice and damages stands of perennial pasture and hay.

The spring flood may carry enough sediment to damage city residences by mud deposits as well as by flooding. The sediment load is generally too small to cause damage on the agricultural land other than minor erosion and deposition in the agricultural area. The principal damage from the spring flood is the delay in farm operations which is caused by ponding of flood water from spring snowmelt and run-off from the upper watershed lands. The crops grown on these lands are limited to those that will withstand flooding or will mature in a reduced growing period. In years with late spring flooding much of the cultivated land is left idle. If seeded late in the spring, the crop is subject to fall frosts. The development of bottomland along the Bear River is hampered by frequent flooding from Montpelier Creek. Some of these lands are in low production of hay or pasture, or maintained in inferior stands due to the difficulty of reseeding.

Damages to agriculture and urban areas from floodwater in Montpelier Creek are closely interrelated. It has become customary to divert part of the flood flow on to the farm land through the irrigation canal system. In some floods this practice has prevented damage to the town of Montpelier; in other instances it has effectively reduced the damage.

High flood flows of several days' duration are a serious hazard to human life in Montpelier. The stream channel, which passes through the school ground and residential area, is fairly steep and high flows are so turbulent that persons who might fall into the creek would have difficulty in getting out. One child has drowned and six other near drownings have been reported.

Floods have occurred during the years of 1943, 1948, 1950, 1952, 1955, 1962 and 1963. During 1962, floods occurred during the months of February and

April. These floods caused damage to the City of Montpelier and 5,736 acres of adjacent agricultural land.

Agricultural Water Management Problems

The Montpelier Creek Irrigation Company owns the right to divert all of the flow of Montpelier Creek during the irrigation season. This is the only source of irrigation water for most of the land served by the Irrigation Company. Under existing conditions the irrigation water supply is usually in excess of requirement up to the middle or late part of June. From the first of July until the end of the irrigation season the demand is greater than the supply. During 80% of the years the June supply of water will irrigate approximately 5 times as much land as the water supply will properly irrigate in July and August.

Water is usually delivered on a rotation basis. In low water years flows are too small to provide a continuous irrigation stream in every canal and ditch. This causes many of the distribution systems to be dry from time to time during July and August and requires considerable water to rewet the canals and ditches for each rotation. Frequently, the intervals between rotation are too long to maintain adequate soil moisture for proper plant growth. Many crops are damaged beyond the point which they can recover with subsequent irrigations. The on-farm irrigation systems are primitive and the water application methods are inefficient according to modern standards. Most of the land that is irrigated by surface methods need leveling. Progress in revising irrigation systems, land leveling and irrigation water management has been retarded by the hazard of flooding as well as by the shortage of irrigation water during the latter part of the growing season.

Sediment Problems

Sediment damages in the watershed occur chiefly to the irrigation distribution system flanking the dryland farming area, to crops, cropland, and to residential housing and commercial developments along the banks of Montpelier Creek through the City of Montpelier. Damages through town are caused by flood waters carrying fine silts that are deposited in and around houses and buildings smothering lawns and moving into basements resulting in costly cleanup and repairs.

Fine silt sized sediment derived from overland flow from the outlying dryland farming area and occasionally coarser debris from adjoining mountainous lands contribute substantial quantities of sediment almost annually to the irrigation systems. Small grain crops along the lower slopes of the dryland area receive significant damages from smothering by fine sediment. Sediment in the main channel also has resulted in considerable damage to the highly productive fishery in Montpelier Creek.

Sediment yield from the dryland area under present conditions is estimated to be 11,000 tons per year at the north and south canals. The sediment yield from Montpelier Creek is estimated to be 7,950 tons per year at the mouth of the canyon.

Erosion Damage

Significant erosion damages in the watershed are mainly confined to the dryland farming area at the lower end of the watershed and to the mountainous headwaters area forming the upper half of the watershed above the proposed reservoir site on Montpelier Creek. Accelerated erosion in the Mountainous headwaters consists predominantly of sheet erosion followed by gully and roadside erosion. These forms of erosion all contribute fine sediment which damage improvements through the City of Montpelier.

Accelerated erosion on the dryland consists of sheet erosion which is the chief source of sediment clogging irrigation improvements downslope. Damages from sheet erosion, both on the drylands and in the mountainous headwaters, are twofold in nature. Sheet erosion not only contributes the major portion of damaging sediment downstream but it also is a selective process robbing the soil profile of its irreplaceable top soil and thus its fertility and ability to support vegetative growth.

PROJECTS OF OTHER AGENCIES

No water resource development projects are planned by other state or Federal agencies that will affect or be affected by Works of Improvement proposed in this project.

BASIS FOR PROJECT FORMULATION

The land treatment and structural measures selected for inclusion in this plan are those measures that will achieve the project objectives at the lowest annual cost.

The project objectives include:

1. Prevention of permanent destruction of the land resources of the watershed and the reduction of sediment production to a practical minimum.
2. Provide adequate level of protection to the maximum feasible area of the flood plain.
3. Obtain efficient and sustained productive use of the agricultural land and water resources of the watershed.
4. Restoration of forage production on the rangeland of the watershed.

Land Treatment Measures

Land treatment measures to be installed on National Forest land are based upon an analysis of the land condition and needs by the Forest Service. The measures selected for inclusion in this plan are those needed to reduce sediment production, prevent further land deterioration, stabilize critical areas, restore forage production, and assist in achieving the project objectives. These measures were jointly evaluated by personnel of the land administering agency, Soil Conservation Service and the local sponsors.

Land treatment measures to be installed on private lands were based upon Soil Capabilities, and land needs. The measures selected are the minimum needed to reduce sediment production, prevent sheet and gully erosion, prevent further deterioration of the land, relieve water logged areas, and to permit the efficient and sustained productive use of the agricultural land and water resources of the watershed. These measures were jointly evaluated by personnel of the Soil Conservation Service and the local sponsors.

Structural Measures

Structural measures included in this plan are those found to be the least costly method of supplementing the land treatment measures to accomplish the objectives of the plan.

The level of flood protection for the urban area of the City of Montpelier was set to prevent flooding by 1% chance event. This level of protection was chosen to satisfy the desires of the local sponsors and in accordance with the provisions of P. L. 566 and Policy Statements of the Secretary of Agriculture. This event is somewhat larger than the largest event of record.

The level of flood prevention for agricultural lands was set to prevent flooding by the 10% chance event. Additional protection is planned for areas where additional benefits will exceed the added costs, and where the failure of a structure would endanger a major improvement. This level of protection is needed to encourage the most profitable use of the land and to reduce the remaining flood hazards to a comparable level with frost hazard, etc.

The level of protection to roads, railroad, highway, and public utilities was selected to coincide with the level of protection for the areas including it.

To provide the desired level of protection to the City of Montpelier from water originating on the drainage area of Montpelier Creek below the dam, during the winter flood, will require channel capacities of 150 cubic feet per second. Economical and physically feasible storage sites are not available to regulate the run-off from this sub-area.

The maximum detention capacity required for flood prevention on Upper Montpelier Creek is that which will reduce the peak flows to the capacity of the channels required to carry the flows resulting from the winter flood on lower Montpelier Creek. This capacity was determined to be approximately equal to that to be provided for irrigation water storage in the reservoir. Dual use of the same capacity for flood prevention and irrigation storage was found to be feasible. The one percent chance flood event from this area is the result of snow melt, and has a large volume but a low peak rate of flow. The dam is designed so that a combination of flow through the gated outlet and the use of the available storage will handle the expected one percent chance event without flow through the emergency spillway and without exceeding the capacities of the channels to be provided below. A determination of whether the reservoir will be operated in early season for flood prevention (snow melt flood) or for irrigation storage will depend upon the forecast of potential stream flow. A forecast procedure was developed

(described in the Hydrology Section of this work plan) which was found to be accurate for thirteen years of stream flow record, based on the snow survey records.

A small detention site is available on a small unnamed draw that contributes flood water to the south edge of the City of Montpelier, the adjacent agriculture lands and public utilities. The capacity of this site is limited by the topography to an overtopping capacity of approximately 15 acre feet. Existing channels to the river will carry 13 cubic feet per second with only minor improvements.

Flood water detention sites are not available to control flood flows from the additional sub-areas north of the City of Montpelier that contribute to the flood damages of agricultural lands and public utilities. Channelization is proposed to reduce flood damages from these sub-areas, including Joe's Gap.

Structural measures proposed for Agricultural Water Management were agreed upon by the Irrigation Company and other local sponsors. Only those measures required to obtain efficient and sustained productive use of the land and water resources of the watershed, and to obtain the benefits used to evaluate the project are included in this work plan.

The storage capacity for agricultural water management to be included in the reservoir is based upon the full utilization of the eighty (80) percent chance supply. Water requirements are based upon the estimated consumptive use of the crops to be grown, anticipated field application efficiency, estimated farm and canal seepage losses, evaporation, estimated reservoir seepage losses and the probable releases required to maintain stream flow and fish habitat below the dam during the non-irrigation season. Based upon the assumptions made, 3,840 acre feet of active storage is required. This will furnish a full water supply to 3,400 acres of land. Storage capacity of 210 acre feet is provided to store the anticipated 100 year supply of sediment accumulation.

Portions of the existing irrigation system will be enlarged to meet the peak delivery demands of the land to be irrigated from them. The system will be improved and modernized to permit controlled, measured delivery of the water supply to individual farms.

The topography and location of areas affected by poor surface drainage and high water table, control the location of community outlet drains. The elevation of the Bear River in respect to the elevation of the affected area limit the depth of the drains and thus the depth of sub-surface drainage. The Bear River is controlled for power production by diverting the high flows into Bear Lake above the project area and subsequently releasing the stored water late in the summer when the electrical demand exceeds the capacity available from the normal low stream flows. The water level in the Bear River, through the project area, is normally low when flood flows occur in the project area. The late summer water level in the river will limit outflow of seepage and waste water from the area.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Land treatment measures planned for installation as a part of this watershed project were selected for the particular problem areas involved. Measures proposed are those which the Federal and State agency personnel and the sponsors felt, based on their experience and judgment, would help to solve the problems and develop the resource to its maximum.

Land treatment measures to be applied can generally be grouped into two treatment areas:

1. The upper watershed and foothills area principally composed of Federal, state and private range land areas and private dry crop land.
2. Lower watershed and valley floor principally comprising the irrigated, urban and miscellaneous land areas.

Measures proposed for the upper watershed can be further sub-divided into two categories.

- a. Measures in the first category include contour trenching, re-seeding, gully stabilizations, fencing, head cut structures and other erosion control measures. These measures are to be installed on critical flood and sediment source areas located in the higher elevations. Their primary effect will be to reduce erosion, flood water and sediment damage to structures and residential and agricultural areas downstream.
- b. The second group of measures include sagebrush spraying, seeding, willow planting, fencing, water developments and proper range use. These measures will also reduce sediment production and will improve the vegetal cover and increase forage production. Additional fire protection of National Forest lands will be needed during dam construction and reservoir clearing time. This will be provided by the Forest Service. Measures to be applied to dry crop lands will include contour cultivation, stubble mulch farming, field strip cropping and related practices. These practices will reduce sediment production and flood water erosion and will halt the land deterioration currently underway.

Land treatment on the valley lands will be confined largely to the irrigated cropland. These measures will serve to increase farm irrigation efficiencies, soil fertility, and crop yields, and will generally improve the agricultural economy of this rural community. Through the proper application of these measures on the irrigated land, available water supplies can be made to serve land areas which are now short of water. Principal practices to be installed are land leveling, construction of field ditches and structures, drainage, irrigation water management, installation of sprinkler irrigation systems and conservation cropping systems.

Estimated cost of land treatment measures are listed in Table I.

Summary of Cost For Land Treatment Measures

The total installation cost for land treatment measures is estimated to be \$737,008 of which \$188,625 or 26% will be from P. L. 566 funds and \$548,383 or 74% will be from other funds.

The cost of measures in addition to those to be installed under the regular program of the Forest Service on the National Forest lands, estimated at \$112,125 will be borne from P. L. 566 funds. The cost of the going program on the National Forest is estimated to be \$125,653 and will be borne from regular Forest Service appropriations as they are made available.

No land treatment measures are planned for National Land Reserve Lands.

The cost of the total land treatment program on state and private lands will approximate \$499,230. Other funds will bear the estimated cost of \$422,730 for the application of land treatment measures by private land owners and operators. Only the cost of additional technical assistance needed for accelerating the application of needed land treatment measures on private and state lands will be borne from P. L. 566 funds.

In cooperation with the Idaho State Forestry Department, the Forest Service has determined that no additional forestry practices or fire prevention measures are needed on state and private lands outside the National Forest boundary.

Structural Measures

These measures will provide flood protection to agricultural lands, the City of Montpelier, and public utilities, provide for more efficient use of the irrigation water supply, increase the water supply available for mid and late season use, and will supplement the land treatment measures in reducing erosion, sediment, and flood damages.

See Table 1 for Summary of measures and costs, and Table 2 for cost distribution. See Table 3 for design features of the structures. The Project Map shows the location of structures.

Structural measures include:

1. A multiple purpose dam and reservoir on Montpelier Creek with a total storage capacity 4,050 acre feet of which 3,840 acre feet will serve as dual purpose flood prevention detention and irrigation water storage, 210 acre feet will serve as sediment storage. This dam will have a maximum height of 82 feet below the fill crest, a crest length of 880 feet. The dam will be composed of a zoned type earth and rock fill with an impervious earth core and will control the flow of 27.5 square miles of the watershed. The principle spillway consists of a gated conduit with the inlet set at the elevation of the top of the sediment pool. The emergency spillway will be concrete lined.

The estimated installation cost is \$1,338,000.

The dam and reservoir will be located entirely on National Forest land. A special use permit will be obtained from the U. S. Forest Service. This permit will contain provision for released flows so as to maintain a minimum flow of 4 cfs at the confluence of South Fork and the main channel.

2. The stream channel improvements (pipeline) will carry approximately 110 cubic feet of flood flows through the City of Montpelier. This work will consist of straightening and improving approximately 1,150 feet of the stream channel and installing approximately 3,650 feet of 48 inch pipe through the densely populated area of the city. This channel, when used in conjunction with the North Canal and the North Drain, will provide the desired flood protection to the city and the agricultural lands immediately west of the city.

The estimated installation cost is \$128,075.

3. The North Canal will be enlarged and improved throughout 15,740 feet of length. The first 8,040 feet and the diversion structure at the upper end will serve as an irrigation canal and flood diversion channel to protect the City of Montpelier when flood flows exceed the capacity of the stream channel improvements through the city. This portion of the channel will have design capacity of 60 cubic feet per second with 2 feet of freeboard for irrigation purposes and 60 cubic feet per second for flood protection. The overtopping capacity will be 192 c.f.s. when free of obstructions. The remaining 7,700 feet of canal, and the water control structures will serve only as irrigation facilities. This canal will have a capacity of 60 cubic feet per second at the upper end and 15 cubic feet per second at the lower end. This canal will, when used in conjunction with the reservoir and channel improvements, provide the desired level of flood protection to the City of Montpelier, agricultural lands adjacent to the City, and public utilities; and will provide measured, controlled delivery of irrigation water to the individual delivery points of the farms served by it.

The estimated installation cost is \$42,400.

4. The diversion will consist of 6,000 feet of grassed waterway and dikes above the North Canal to collect the run-off from Joe's Gap and other short steep draws and conduct it to the head of the North Drain. This channel, with a capacity of approximately 40 c.f.s. will reduce flood and sediment damages to the North Canal, U. S. Highway 30N, and the agricultural lands below.

The estimated installation cost is \$5,500.

5. The North Drain extends 18,725 feet from the North Canal in the NW $\frac{1}{4}$ of Section 35 to the Bear River near the west edge of Section 29. The upper 1,265 feet of this channel serves the single purpose of flood prevention. The lower 17,460 feet will serve as dual purpose flood prevention and drainage channel. The upper 1,265 feet of this channel will consist of a control structure at its junction with the North Canal and a concrete chute with a capacity of 60 cubic feet per second with 2 feet of freeboard and 139 c.f.s. without freeboard. From the end of the chute to the Bear River the channel will be an earth channel excavated into the natural soil to a minimum depth of approximately 3 feet with a capacity of 110 cubic feet per second. All of the lower 17,460 feet will be excavated to below the natural water table.

and will vegetate naturally. This channel, when used in coordination with the reservoir, channel improvements, diversion and North Canal, will provide the desired level of flood protection to the City of Montpelier, agricultural lands west and north of the city and to public utilities including irrigation canals, highways, roads and railroad. The lower channel will provide surface and shallow sub-surface drainage to approximately 320 acres of land and serve as a drainage outlet for approximately 1,600 acres of agricultural land.

The estimated installation cost is \$86,600.

6. A debris basin will be constructed in the small draw near the south edge of Montpelier to reduce flood and sediment damages at the south edge of the urban area, agricultural lands and public utilities in its flood plain. The maximum height of the fill will be 23 feet and the crest length 250 feet. The fill will be of a zoned type construction earth-rock fill with an impermeable core. The principle spill will be an uncontrolled conduit with a maximum capacity of approximately 13 cubic feet per second when passing the 1% flood event. The structure will have a total storage capacity of 7.25 acre feet of which 2.75 will be for sediment storage and 4.5 acre feet for flood detention. The structure will control the flow from 0.85 square miles of watershed. The emergency spillway will be vegetated. The sediment storage capacity of 2.75 acre feet will require periodic clearing approximately every 10 years. Cost for this is included in the operation and maintenance estimate.

The estimated installation cost is \$18,500.

7. The irrigation canal consists of enlarging and improving 8,500 feet of existing canal south of Montpelier Creek and installing water control structures to measure, control and deliver 15 cubic feet per second of irrigation to the individual delivery points.

The estimated installation cost is \$23,600.

EXPLANATION OF INSTALLATION COSTS

Costs

Land Treatment Measures

Installation costs for land treatment measures on private and state lands are based on estimates of all costs associated with establishing the measures. With the exception of those costs that might be shared through the USDA Agricultural Stabilization and Conservation Program, all costs will be borne by the individual land owners and operators.

Installation costs for land treatment measures on Federal land includes the cost for establishing the practice, associated technical services including the making of surveys to determine the exact location of the treatment, and overhead supervisory costs.

Estimates of quantities and costs for all land treatment measures are based upon surveys of watershed lands and on costs incurred for similar treatment

elsewhere. All costs reflect current and local prices for the services, equipment and materials involved in the application of each practice. Estimated costs for technical assistance are based on analyses of the costs for planning and applying similar measures. Technical assistance includes the salaries and associated costs of technicians who will assist owners and operators in the application of the measures.

Structural Measures

Installation cost as shown on Tables 1 and 2 includes all costs to be incurred in construction of the structural measures. These include construction cost, installation services, land easements and rights-of-way, water rights and administration of contracts.

Construction costs shown for each structural measure represents the best engineering estimate available for this type construction. A 15% contingency allowance is included for each construction item except that for the multiple purpose dam where 50% was used for the item of grouting.

Costs for installation services includes all personnel services costs associated with survey, design, preparation of specifications and contracts and supervision of construction.

Installation services costs were estimated at 2.5% of the construction cost. Engineering services make up 60% of the installation services cost and other personnel services account for 40%. Additional installation services costs are included for the multiple-purpose dam, for foundation investigation and materials testing prior to final design.

Land rights costs consist of the fair value of the rights and cost of legal and personnel services associated with their acquisition. Land rights costs made for each structural measure represents locally made estimates based on experience for similar acquisitions. These costs include estimates of \$57,000 for relocation of the Forest Service road at the multiple-purpose reservoir site and \$18,000 for protection and replacement of utilities including roads, bridges, water and gas pipes, power lines, fences, etc., \$7,000 to provide needed farm crossings and channels and \$7,680 for land acquisition.

Contract administration costs include costs of all personnel services, overhead and other costs associated with the administration of the contracts.

Cost of water rights represents the estimated cost or appraised value of water rights necessary to be acquired to carry out the project.

The Montpelier Creek Watershed includes three multiple-purpose structures. Allocations of costs to purposes served are in accordance with the provisions of P. L. 566 and policy statements of the Secretary of Agriculture. The use of facilities method was used to allocate the cost of the multiple purpose reservoir. Costs of the multiple purpose portions of the North Canal and North Drain were allocated by estimating costs of single purpose channels required to produce the same benefits, and allocating the multiple purpose costs in the ratio of the cost of each single purpose channel to the sum of the costs of the several single purpose channels.

The proportion of the installation cost allocated to each purpose is illustrated in Table form for each multiple-purpose measure.

Installation Costs Allocated to Purposes					
Structures	Flood Prevention		Agri. Water Management		Total
	Sediment	Floodwater	Irrigation	Drainage	
Multiple-Purpose Reservoir	\$69,570	\$634,215	\$634,215		\$1,338,000
Percent	5.2%	47.4%	47.4%		100%
Multiple-Purpose Irrigation Canal		\$ 12,370	\$ 30,030		\$ 42,400
Percent		29.2%	70.8%		100%
Multiple-Purpose Drainage Channel		\$ 69,620		\$16,980	\$ 86,600
Percent		80.4%		19.6%	100%

Cost Sharing

Project costs are estimated to be \$2,379,683. P. L. 566 funds will provide \$1,455,525 or 61% and other funds will provide \$924,158 or 39% of this cost.

The following costs will be borne from P. L. 566 funds:

1. Cost of technical assistance for accelerated land treatment on non-Federal land, \$76,500.
2. Construction costs allocated to flood prevention, estimated at \$690,150.
3. 50% of the construction cost allocated to agricultural water management measures, estimated at \$259,720.
4. Costs of installation services for structural measures, \$317,030.
5. Cost of installing accelerated land treatment measures on Federal lands - \$112,125.

Total P. L. 566 costs - \$1,455,525

P. L. 566 costs allocated to Flood Prevention Measures \$998,410

P. L. 566 costs allocated to Agric. Water Mgt. Measures \$457,115

The following costs will be borne from other funds:

1. Cost for application of land treatment measures to be installed by individual owners and operators on private land, \$402,730.
2. Cost of technical assistance for going program for land treatment measures on non-Federal land \$20,000.

3. Cost of installing land treatment measures on Federal land under going program \$125,653.
4. 50% of the construction cost allocated to Agricultural Water Management measures, estimated at \$259,720.
5. Easements and rights-of-way costs - \$89,680.
6. Costs of water rights - \$2,000.
7. Costs for administration of contract for project installation - \$24,375.

Total Other Costs - \$924,158

Other costs allocated to Flood Prevention Measures \$277,063

Other costs allocated to Agric. Water Mgt. Measures \$647,095

Schedule of Expenditure of Funds

Years	P.L. 566	Other	Total
First	\$163,045	\$ 62,077	\$ 225,122
Second	887,530	367,862	1,255,392
Third	243,440	118,092	361,532
Fourth	94,850	116,512	211,362
Fifth	25,780	100,942	126,722
Sixth	26,380	85,943	112,323
Seventh	10,000	55,000	65,000
Eighth	4,500	17,730	22,230
Total	\$1,455,525	\$924,158	\$2,379,683

EFFECTS OF WORKS OF IMPROVEMENT

The land treatment and structural measures included in this plan can generally be grouped into two types of measures on the basis of the benefits which each group of measures is designed to accomplish.

They are:

1. Floodwater, erosion and sediment damage reduction through the installation of land treatment and structural measures in the upper watershed, foothill area and flood plain.
2. Agricultural water management benefits through the construction of a multi-purpose reservoir, renovation of the irrigation distribution system, construction of a dual purpose floodway and drain and application of on-farm land treatment measures.

Floodwater and Sediment Damage Reduction

Land treatment measures scheduled for installation on range and dry land areas in the upper and foothill portions of the watershed will assist in alleviation flood runoff and sediment production. The combination of seeding, fencing, trenching, and improved grazing management will stabilize critical flood source and sediment producing areas and prevent damage to lower lying lands and facilities. Brush spraying and seeding on selected areas will arrest widespread erosion and will also provide additional forage for grazing.

Land treatment measures proposed for installation on the National Forest, private and state lands above the multiple-purpose reservoir will reduce the average annual sediment yield by 20%.

The structural measures for flood control will afford protection to the City of Montpelier and surrounding agricultural lands. The multiple-purpose reservoir, together with the multiple-purpose channel above and north of the city, the stream channel improvements to be built through the city and the debris basin and Joe's Gap diversion will afford flood protection from a 1% flood event from Montpelier Creek to the 3,250 residents of Montpelier and to 4,986 acres of agricultural land representing 63 farm families. An additional 750 acres of agricultural land will receive flood protection from a 10% event.

The Joe's Gap diversion channel will collect flood flows from the lower lying foothill area and channel them to the north floodway. This will afford protection from flood and sediment damage to adjacent irrigated and dry cropland as well as protection to U. S. Highway 30N and secondary roads and the north canal.

The debris basin will furnish protection to the highway, agricultural lands and facilities that lie below.

Agricultural Water Management Measures

Land treatment measures to be applied to the irrigated land will improve farm irrigation water efficiencies and provide for the application of improved farm management techniques. It is estimated that present on-farm irrigation efficiencies average 25%. Present farm ditch losses are estimated at 10% and canal seepage losses at 15%. With the project it is estimated that field irrigation efficiencies will be 55% and farm ditch and canal seepage losses will each be 10%.

The storage capacity of 3,840 acre feet of irrigation water to be provided by the multiple-purpose reservoir will furnish additional irrigation water supplies for 3,400 acres. This water will furnish a full season irrigation supply and will be made available in accordance with the crop needs. Renovation and reorganization of the main canal and distribution system will provide for more efficient scheduling and distribution of water.

The multiple-purpose flood channel and drainage way will provide drainage to 320 acres and a drainage outlet for 1,600 acres of land. Some of these

lands are currently producing very little useable forage. Through the installation of a drainage system high quality forage can be produced.

It is not anticipated that the cropping pattern will change radically with the project. Farm enterprises are basically built around a livestock economy and the basic change that will be made in crop production is an increase in high quality hay and improved pasture crops and a decrease in the quantities of low quality forage now being produced. This will increase farm income and will strengthen the economy of this rural community.

Recreation

The multiple-purpose reservoir will furnish opportunity for incidental recreation benefits even though no specific capacity is planned for this purpose. Normal operation will provide an average surface area of 105 acres for fishing during the May - August recreation season. It is estimated that this will provide 5,900 fisherman trips per year to the reservoir.

PROJECT BENEFITS

Flood Prevention Benefits

The total annual benefits from the structural measures for flood prevention amount to \$69,296. This includes \$37,100 in damage reduction benefits and \$32,196 in more intensive land use benefits.

The multiple-purpose reservoir and distribution system will produce \$51,321 in annual flood prevention benefits. Of this total, \$25,929 or 51% will be made up of damage reduction benefits and \$25,396 or 49% in more intensive land use benefits. Of the total damage reduction benefits 70% are composed of crop and other agricultural damage reductions while 30% are non-agricultural damage reductions.

The diversion and multiple-purpose channel to be installed north of Montpelier will produce \$10,160 in annual flood prevention benefits. Of this total, \$4,080 or 40% are damage reduction benefits and \$6,080 or 60% in more intensive land use benefits. Of the total damage reduction benefits 91% will accrue to agriculture and 9% to non-agriculture.

The debris basin to be installed in a side drainage south of Montpelier will produce \$1,265 in annual flood prevention benefits. Of this total, \$545 or 43% are damage reduction benefits and \$720 or 57% are more intensive land use benefits. All the flood prevention benefits produced by the installation of the debris basin will accrue to the agricultural sector of the economy.

The stream channel improvement through the city will produce \$6,550 in flood prevention benefits. All these benefits are from damage reductions in the City of Montpelier and are divided among residential, business, railroad, and public properties in the city.

Land treatment on the upper watershed and foothills, particularly contour trenching, reseeding, gully stabilization, fencing, and head cut structures on range land; contour cultivation, stubble mulch farming, and field strip

cropping on dry crop land, will reduce floodwater and sediment damages by an estimated 3%. This will produce annual flood reduction benefits of \$1,210.

Agricultural Water Management Benefits

The estimated benefits accruing to the agricultural water management phase of the project after deducting the cost of associated land treatment measures will total \$42,768. Of this total, \$36,575 will result from increased supply of irrigation water and \$6,193 will accrue to improved drainage.

The prevention of flooding, increased supply of irrigation water, and improved drainage will give rise to increased agricultural production through improved management of the soil and water resources. Increased net income from this effect of the project will amount to \$32,196 annually and is designated as benefits from more intensive land use.

The following tabulation indicates the kind and amount of benefits by problem areas which will result from the installation of the project measures.

<u>Kinds of Project Benefits by Evaluation Areas</u>				
<u>Areas</u>	<u>Total</u>	<u>Irrigation</u>	<u>Drainage</u>	<u>More Intensive Land Use</u>
Surface Irrigated Area				
Irrigation only	\$18,267	\$18,267	--	--
Irrigation & Flood	29,225	14,613	--	\$14,612
Irrig., Flood & Drainage	11,086	3,695	\$3,695	3,695
Sub-Irrigated Area	4,995	--	2,498	2,498
Sprinkler Irrig. Area	11,391	--	--	11,391
Total	\$74,964	\$36,575	\$6,193	\$32,196

Recreation Benefits

The Montpelier Creek Watershed area is an important recreational area. The Forest Service will handle all recreational developments above and below the reservoir site under their going program through the multiple-use program for the National Forest. Therefore only the increased value of fishing in the reservoir will be treated as a project benefit. The construction of the multiple-purpose reservoir will enhance an already excellent recreational area. Though there will be no specific body of water in the reservoir reserved for recreation, there will be incidental recreation benefits accruing from the impoundment of an average annual surface area of 105 acres for fishing during the May - August recreation season.

The incidental recreation benefits from this impounded water will amount to \$6,500 annually after deducting the associated cost of stocking the reservoir.

Other Economic Benefits

The average size farming operation in the area which is supplied water from the irrigation system, presently has a net crop value of approximately \$893 per year. With the project the same farm operation will have a net crop value of approximately \$3,446 minus charges levied by the irrigation company for project agricultural water management costs. The term net crop value equals the gross long term value of the crops grown minus all associated farm charges except interest on the land investment and a managerial charge for the entrepreneur. The present low income level in agriculture will be transformed into a more profitable enterprise through the installation of the project.

The true value of this project cannot be measured in dollars and cents. The first thing a farmer in this situation will do when profits increase is to upgrade the quality of his equipment and then increase his expenditure for consumer goods. This produces a community multiplier several times larger than if the present income level of the farmers were more profitable.

When a community or area is operating in the lower economic quartile and they are able to improve their situation, the ratio of expenditures for items used in production and reinvestments to savings will be higher than in more prosperous areas. The project will mean more prosperity to all the people in the area. There will be increased expenditures for cars, trucks, farm machinery, fertilizer, and consumer goods sold by the local stores. A higher percent of the students graduating from high school will be able to go on to college. The social and economic impact of this project upon the welfare of the community is unmeasurable though it is known to be substantial.

The watershed and range development programs of the Forest Service are designed to provide stable watershed conditions and the maximum possible forage for livestock that is consistent with good watershed management. By agreement with the Forest Service, operators who hold National Forest grazing permits to graze the area will benefit from additional forage that is produced by the going and accelerated programs.

The construction of campground facilities by the Forest Service under their regular program will provide additional benefits to the community.

COMPARISON OF BENEFITS AND COST

Total average annual benefits from the structural measures will be \$118,564 and the annual costs of installing and maintaining these measures will be \$64,645. The overall benefit cost ratio is 1.8 to 1.

Secondary benefits have not been evaluated or used in project justification.

PROJECT INSTALLATION

The project work plan will be carried out jointly by local, state and Federal interests.

Non-Federal interests include individual farmers and ranchers in the watershed, Bear Lake Soil Conservation District, City of Montpelier, Montpelier Irrigation Company, Idaho State Land Board, Idaho State Forester, Idaho State Department of Reclamation, Idaho State Extension Service, and Idaho Fish & Game Department.

Federal interests include the Soil Conservation Service, Forest Service, Bureau of Land Management, Farmers Home Administration, Fish & Wildlife Service and the State & County Agriculture Stabilization & Conservation Committees.

Local sponsors will acquire necessary water rights, lands, easements and rights-of-way, special use permits, execute agreements with owners of private lands for installation of land treatment measures, provide the non-Federal share of the installation costs of structural measures and cooperate with the local, state and Federal agencies concerned with the project. Local sponsors will also contract for the construction of the structural measures listed in the work plan.

The City of Montpelier, incorporated under the laws of the State of Idaho, has powers of taxation, eminent domain, can accept contributions, levy assessments, hold elections for loan or bond authorization, make annual levies to retire obligations, and enter into special agreements for construction and operation and maintenance of improvements.

The Montpelier Irrigation Company, is legally organized under the laws of the State of Idaho. It has powers of eminent domain, can accept contributions and levy assessments against their stock for repayment of obligation and operation and maintenance costs.

The Bear Lake Soil Conservation District is legally organized under the laws of the State of Idaho. It is empowered to enter into agreements and contracts to carry out soil and water conservation operations and apply soil conservation treatments within the boundaries of the district.

The Federal Land Administering agencies have concurred in the provisions of the work plan.

Responsibilities for Installation

In order to coordinate the installation of the accelerated land treatment and structural measures provided for in the plan and the going conservation programs in the watershed, close cooperation and specific responsibilities are required of all interests assisting with this project.

Bear Lake Soil Conservation District will:

1. Provide local leadership and direction which will continue the going program of the district at the rate which existed prior to the development of this work plan.
2. Provide local leadership to insure the scheduled installation of the accelerated land treatment measures on private and state lands.

Montpelier Irrigation Company will:

1. Survey, acquire and record all necessary lands, easements, rights-of-way, including relocation of road around dam site, water rights and special use permits for the multiple-purpose dam and reservoir, multiple-purpose north channel including the canal and drain, Joe's Gap diversion, south irrigation canal and the debris basin. (A permit to store water in the proposed multiple-purpose reservoir has already been issued to the Irrigation Company by the Idaho State Reclamation Engineer).
2. Act as the local contracting organization for the construction of these measures and furnish the non-Federal share of the construction cost.
3. Provide leadership, encourage and assist water users under their system to attain more efficient use of available water supplies through application of scheduled land treatment and better management practices.

City of Montpelier will:

1. Survey, acquire and record all necessary lands, easements and rights-of-way for the stream channel improvements (pipeline) to be installed through the City of Montpelier.
2. Act as the local contracting organization for the construction of these improvements and furnish the non-Federal share of the construction costs.
3. Cooperate with the Montpelier Irrigation Company and the Bear Lake Soil Conservation District in providing local leadership and direction for the installation of works of improvement planned as part of the project.

The Soil Conservation Service will:

1. Furnish necessary technical assistance through the Bear Lake Soil Conservation District to private land owners for installation of land treatment measures on non-Federal lands.
2. Furnish the necessary installation services for engineering surveys, designs, construction plans and specifications, and supervision of construction for installation of the structural measures.

3. Provide construction funds for the project in accordance with the cost sharing and time schedules set forth herein or as revised by mutual agreement and in accordance with national practices and availability of appropriations.
4. Maintain liaison with sponsors and state and federal agencies participating in the project to the end that unified effort and coordinated action will produce the most effective results.
5. Consult with and assist the sponsoring organizations, local, state and federal agencies in making desirable revisions or amendments of this plan if and when circumstances dictate.

The Forest Service will:

1. Install the land treatment measures on National Forest land in accordance with the program outlined in Table 1 and/or as funds are made available.
2. Adjust grazing and other uses on National Forest land to facilitate the installation of the planned works of improvement. These measures have been scheduled for installation in a sequence which will necessitate the least practical inconvenience and unfavorable economic impact on permittees having grazing preference.
3. Coordinate treatment, use and management of National Forest lands contiguous to treatment areas of state and private lands to effect minimum treatment costs and optimum utilization of lands.
4. Furnish technical assistance for planning and application of practices under its departmental responsibility for technical phases of the program.
5. Authorize, as approved by the Forest Supervisor, access road, borrow areas and other land occupancy needed by the project sponsors, by special use permits and administer the use in accordance with the provision of the permit.

The Bureau of Land Management will:

1. Continue their present program of installing range improvements on grazing allotments in the watershed.

The Idaho State Land Board will:

1. Cooperate with leasees of state land and in cooperation with the U. S. Forest Service continue to seek proper management and grazing of state lands in the watershed.

The State Reclamation Engineer will:

1. Furnish the sponsors with any assistance required to obtain water and storage rights needed for the project.

The Idaho Cooperative Extension Service will:

1. Give high priority in carrying out an effective education and information program in cooperation with sponsors of the project.

The State and County ASC Committees will:

1. Give high priority to scheduling ACP funds to expedite the land treatment on private and state lands.

Schedules for Installation

The going conservation program of the Bear Lake SCD and Federal agencies cooperating in this project are an integral part of this plan and are planned to continue at the same rate that existed prior to development of the watershed work plan.

The installation of accelerated land treatment measures for flood prevention will begin during the first year of the project and will be completed during an 8 year project period. Treatment and adjustment in use will be made in accordance with the schedule for the installation of the structural measures. The schedule for installation of structural measures for flood prevention has been made to concur with or follow the installation of the required land treatment measures.

Installation of land treatment measures for Agricultural Water Management will begin during the first year of the project, however, the majority of the on-farm irrigation practices will not be applied until after the multiple-purpose irrigation reservoir has been constructed. The installation of these land treatment measures will be completed during an 8 year project period, however, increased irrigation efficiencies brought about by the application of related farm management practices will continue for many years after project installation is completed.

The proposed installation schedule is as follows:

Caribou National Forest

- 1st Year - Install treatment - access road to trench area 3 miles; contour trenching head of Montpelier Creek 160 acres; gully plugs, Montpelier Creek 44 each; fire protection during installation.
- 2nd Year - Install treatment - contour trenching, Beaver Dam Creek 60 acres, Whiskey Flat 120 acres; fire protection during installation; maintain previously installed treatment.
- 3rd Year - Install treatment - contour trenching, Snowslide Creek 115 acres; gully plugs, Beaver Dam Creek 126 each; drop structures, Beaver Dam Creek, 4 each; grass waterway, Whiskey Flat 1 mile; roadside erosion control, Snowslide Road, 1 mile; fire protection during installation; maintain previously installed treatment.

- 4th Year - Install treatment - gully plugs, Whiskey Flat 450 each, Pruess Creek Divide - 25 each; drop structures, Whiskey Flat 27; head cut structures Whiskey Flat 21; Grass waterway, Whiskey Flat 2.2 miles; Roadside erosion control, Whiskey Flat 3 miles; road obliteration, Whiskey Flat, .8 mile; fire protection during installation; maintain previously installed treatment.
- 5th Year - Install treatment - contour trenching, Elbow area 40 acres; gully plugs, Giveout Flat 40 each, Elbow area 50 each; drop structures, Giveout Flat 9 each, Montpelier Creek 11 each; headcut structures, Giveout Flat 4 each; spray sagebrush, Whiskey Flat 310 acres; fire protection during installation; maintain previously installed treatment.
- 6th Year - Install treatment - gully plugs, Snowslide Creek, 100 each; drop structures, Snowslide Creek, 26 each; head cut structures, Snowslide Creek, 9 each; Willow planting, Beaver Dam Creek, 2 miles, Whiskey Flat 2.3 miles; Grass waterway, Montpelier Creek, .5 mile; spray sagebrush Montpelier Creek 320 acres; fire protection during installation; maintain previously installed treatment.

Montpelier Irrigation Company

- 1st Year - Obtain land easements, rights-of-way, special use permits, and water rights for the multiple-purpose reservoir, multiple-purpose channel, multiple-purpose canal, and diversion. Specification - design investigations for the multiple-purpose reservoir. Design, prepare contracts, and begin construction on multiple-purpose channel, multiple-purpose canal and diversion.
- 2nd Year - Design, prepare contracts, and begin construction on multiple-purpose reservoir. Complete construction on the multiple-purpose canal, multiple-purpose channel, and diversion.
- 3rd Year - Complete construction of multiple-purpose reservoir. Obtain land easements, rights-of-way, and water rights for south canal renovation and debris basin. Design south canal and debris basin and prepare contracts.
- 4th Year - Renovate south canal and related structures and construct debris basin.

City of Montpelier

- 3rd Year - Obtain land easements, and rights-of-way for stream channel improvement through the City of Montpelier. Design stream channel improvement, prepare contract, and begin construction.
- 4th Year - Complete construction on the stream channel improvement through the City of Montpelier.

FINANCING PROJECT INSTALLATION

The local sponsoring organizations are legally organized under state laws and are empowered and qualified to install, operate and maintain project measures included in the project plan. They have reviewed program costs outlined in Tables 1 and 2 and have participated in cost sharing decisions. They have given adequate assurance that their share of the installation costs will be available as indicated in the plan.

Installation costs allocated to P. L. 566 funds will be furnished from funds appropriated under the authority of P. L. 566 as amended. This work plan does not constitute a financial document for obligation of federal funds and financial assistance or other assistance to be furnished by the SCS is contingent upon appropriation of funds for this purpose.

Land Treatment Measures

The Forest Service will continue its going program of multiple use management and resource development planned for the area during the project construction period. The work planned and anticipated funds available are shown in Table 1. To complete land treatment measures needed for flood prevention and watershed protection on National Forest land within the project construction period, it will be necessary to accelerate this program. The acceleration will be financed with P. L. 566 funds as shown in Table 1. The going program for Federal lands will be financed from regular funds of the land administering agency.

Cost sharing and other assistance currently available through the going conservation program of the Bear Lake SCD, the ACP, and other Federal and State agencies cooperating in this project are an integral part of this plan and will be expected to be available in the amounts and rates that existed prior to the development of this work plan.

Technical assistance will be provided through the going program at the current rate, for installation of the going program on private lands. P.L. 566 funds will be used to provide technical assistance needed for accelerating the application of the land treatment program on private lands.

The installation cost for land treatment measures on private land will be borne by the individual land owners and operators utilizing cost sharing assistance available through the Agricultural Conservation Program.

County and State ASC Committees have agreed to provide additional cost sharing funds for accelerating the rate of installation of land treatment measures on private lands.

Structural Measures

The Montpelier Irrigation Company will use the loan provision of the Act to help finance their share of the installation cost for structural measures. The Company plans to borrow up to \$348,500 depending on the amount needed to finance the acquisition of easements and rights-of-way. Application to the state Director of the Farmers Home Administration for a loan of this amount has been made. Contracts will be administered by officers and employees of the company.

The City of Montpelier will finance their portion of the installation costs through their normal taxing authority. Surveys for lands, easements, and rights-of-way and administration of contracts will be done largely by officials and employees of the City of Montpelier. Donations, other than by charging nominal costs for easements and rights-of-way are not anticipated.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures installed on Federally-owned land will be operated and maintained from regular funds of the Land Adminstering Agency after the period of installation.

Land treatment measures on private lands will be operated and maintained by the individual land owners. The annual operation and maintenance cost on private lands equal approximately \$8,000 per year.

Structural Measures

Inspections of all works of improvement will be made at least annually and after all floods by representatives of the Bear Lake Soil Conservation District, Soil Conservation Service, and the sponsoring organization responsible for operation and maintenance work as needed.

The Montpelier Irrigation Company will be responsible for the following operation and maintenance operations:

1. Maintain the multiple-purpose reservoir in a safe and serviceable condition and operate it for both irrigation and flood control. Operation includes programming the reservoir releases on the basis of runoff forecasts. The estimated annual cost is \$4,970.

2. Maintain the multiple-purpose canal and the irrigation canal in a safe and serviceable condition and operate it for both irrigation and flood control. Maintenance includes removal of snow to provide flood diversion capacity. The estimated annual cost is \$2,475.

3. Maintain the diversion in a safe and serviceable condition and operate it for flood control. The estimated annual cost is \$210.

4. Maintain the multiple-purpose channel in a safe and serviceable condition and operate it for flood control and drainage. The estimated annual cost is \$2,700.

5. Maintain the debris basin in a safe and serviceable condition and operate it for flood control. The estimated annual cost of \$425 includes cleanout of the basin.

The total estimated annual cost of operating and maintaining the works for which the Montpelier Irrigation Company is responsible is \$10,780. Specific operation and maintenance agreements between the Service and the sponsoring organizations will be executed prior to making funds available for the installation of the works of improvement.

The City of Montpelier will be responsible for the operation and maintenance of the stream channel improvement through the city. Cost of this is estimated at \$1,875 per year.

TABLE 1 - ESTIMATED INSTALLATION COSTS

Montpelier Creek Watershed, Bear Lake County, Idaho

Item	Unit	No. to be Applied			Estimated Cost (Dollars)1/						TOTAL
		Federal Land	Non-Fed Land	Total	P. L. 566 Funds			Other			
					Federal Land	Non-Fed Land	Total	Federal Land	Non-Fed Land	Total	
<u>Land Treatment</u>											
Soil Cons. Service											
Conservation Treat.											
Irrig. Land	Acres		5,700	5,700					362,910	362,910	362,910
Dry Crop Land	Acres		1,790	1,790					17,210	17,210	17,210
Range Land	Acres		4,200	4,200					22,610	22,610	22,610
Tech. Assistance						76,500	76,500		20,000	20,000	96,500
SCS Sub-total						76,500	76,500		422,730	422,730	499,230
<u>Forest Service</u>											
Sagebrush spraying	Acres	2,030		2,030	3,900		3,900	8,400		8,400	12,300
Reseeding	Acres	500		500				7,500		7,500	7,500
Fencing	Miles	3		3				4,500		4,500	4,500
Recreation facilities	Each	14		14				30,000		30,000	30,000
Resource management								75,253		75,253	75,253
Contour Trenching	Acres	495		495	46,400		46,400				46,400
Gully Plugs	Each	835		835	20,875		20,875				20,875
Drop structures	Each	77		77	7,700		7,700				7,700
Headcut structures	Each	34		34	10,600		10,600				10,600
Willow planting	Miles	4.3		4.3	1,300		1,300				1,300
Grass waterway	Miles	3.7		3.7	1,400		1,400				1,400
Road erosion control	Miles	4.0		4.0	1,250		1,250				1,250
Road obliteration	Miles	.8		.8	1,000		1,000				1,000
Access road	Miles	3.0		3.0	3,700		3,700				3,700
Increased fire protection					3,000		3,000				3,000
Operation and maintenance					11,000		11,000				11,000
FOREST SERVICE SUBTOTAL					112,125		112,125	125,653		125,653	237,778
TOTAL LAND TREATMENT					112,125	76,500	188,625	125,653	422,730	548,383	737,008
<u>Structural Measures</u>											
Dam, Multiple-Purpose	No.	1		1	758,420		758,420	235,580		235,580	994,000
Channel, Multiple-Purpose											
North Canal	Ft.		15,770	15,770		19,135	19,135		10,495	10,495	29,630
North Drain	Ft.		18,725	18,725		50,290	50,290		3,710	3,710	54,000
Diversion	Ft.		6,000	6,000		4,140	4,140				4,140
Irrigation Canal	Ft.		8,500	8,500		9,935	9,935		9,935	9,935	19,870
Debris Basin	No.		1	1		14,150	14,150				14,150
Stream Channel Improvement (Pipeline)	Ft.		4,800	4,800		93,800	93,800				93,800
SCS-Sub-Total Construction					758,420	191,450	949,870	235,580	24,140	259,720	1,209,590
<u>Installation Services</u>											
Engineering					163,800	32,310	196,110				196,110
Other					99,200	21,720	120,920				120,920
SCS-Sub-total Installation Services					263,000	54,030	317,030				317,030
<u>Other Costs</u>											
Land, Easements & R/W								60,000	29,680	89,680	89,680
Adm. of contracts								20,000	4,375	24,375	24,375
Water Rights								1,000	1,000	2,000	2,000
Sub-total - Other								81,000	35,055	116,055	116,055
TOTAL STRUCTURAL MEASURES					1,021,420	245,480	1,266,900	316,580	59,195	375,775	1,642,675
<u>TOTAL PROJECT Summary</u>											
TOTAL PROJECT					1,133,545	321,980	1,455,525	442,233	481,925	924,158	2,379,683
Summary											
Total SCS					1,021,420	321,980	1,343,400	316,580	481,925	708,505	2,141,905
Total Forest Service					112,125	-	112,125	125,653	-	125,653	237,778
TOTAL PROJECT					1,133,545	321,980	1,455,525	442,233	481,925	924,158	2,379,683

1/ Prices based on 1964 level

Date February 1964

TABLE 1A - STATUS OF WATERSHED WORKS
OF IMPROVEMENT

(at time of Watershed Work Plan Preparation)

Montpelier Creek Watershed, Idaho

Measures	Unit	Applied to date	Total <u>1/</u> Cost (dollars)
<u>LAND TREATMENT</u>			
Soil Conservation Service			
Irrigated Land:			
Land Smoothing	Acres	200	\$ 5,000
Irrigation Field Ditch	Feet	22,000	200
Pumping Plants for Water Control	No.	3	15,000
Irrigation System Sprinkler	No.	3	45,000
Irrigation Water Management	Acres	705	1,060
Structures for Water Control	No.	100	5,000
Conservation Cropping System	Acres	1,670	1,670
Sub-Irrigated Land:			
Pumping Plants for Water Control	No.	1	3,000
Conservation Cropping System	Acres	880	880
Dryland Cropland:			
Chiseling or Subsoiling	Acres	570	1,710
Stubble Mulching	Acres	380	380
Contour Farming	Acres	60	60
Grassed Waterways	Acres	6.5	750
Range seeding on Converted Land	Acres	550	7,700
Green Manure	Acres	95	190
Conservation Cropping System	Acres	760	760
Miscellaneous Land:			
Conservation Cropping System	Acres	200	200
Range Land:			
Brush Control	Acres	40	200
Range Seeding	Acres	80	800
Fencing for Management	Miles	3	3,000
Farm Pond	No.	1	400
Range Proper Use	Acres	200	200
Sub-TOTAL S.C.S.			\$93,160

(continued)

TABLE 1A - STATUS OF WATERSHED WORKS
OF IMPROVEMENT
(at time of Watershed Work Plan Preparation)

Montpelier Creek Watershed, Idaho

(cont.)

Measures	Unit	Applied to date	Total ^{1/} Cost (dollars)
Forest Service			
Sagebrush Spraying	Acres	1,516	\$ 9,096
Reseeding	Acres	2,538	38,070
Fences	Miles	43.7	69,920
Water troughs	Each	16	12,800
Cattle Guards	Each	7	3,500
Reservoirs	Each	3	1,500
Camp Ground Units	Each	36	43,200
Sub-total - Forest Service			178,086
TOTAL LAND TREATMENT			\$271,246
<u>STRUCTURAL MEASURES</u>			
Water Control Structures	No.	12	4,800
Irrig. Canals & Laterals	Feet	45,000	45,000
TOTAL STRUCTURAL MEASURES			\$ 49,800
TOTAL			\$321,046

^{1/} Price base 1964

Date February 1964

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Montpelier Creek Watershed, Idaho

Structure Site No. or Name	Installation Cost - P. L. 566 Funds			Installation Cost - Other Funds				
	Const. Cost	Instal. Services		Total P. L.	Construc- tion Cost	Adm. of Con- tracts	Other Ease- ments & R/W	Water Rights
		Engin- eering	Other					
Dam-Multiple Purpose	\$758,420	\$163,800	\$ 99,200	\$1,021,420	\$235,580	\$20,000	\$60,000	\$1,000
North Canal								
No. of No. Drain	4,450	1,730	1,160	7,340	4,450	230	470	240
Water Control Strs.	1,725	670	450	2,845	1,725	90	180	90
Remaining Canal	12,960	3,280	2,360	18,600	4,320	460	910	450
North Drain								
Inlet & Chute	36,500	5,450	3,675	45,625		730	200	
Remaining Channel	13,790	2,650	1,725	18,165	3,710	370	17,800	930
Diversion	4,140	620	410	5,170		100	230	330
Irrig. Canal	9,935	1,710	1,140	12,785	9,935	220	440	220
Debris Basin	14,150	2,160	1,440	17,750		300	450	750
Stream Channel Improvements (pipeline)	93,800	14,040	9,360	117,200		1,875	9,000	10,875
TOTAL STRUCTURAL MEASURES	\$949,870	\$196,110	\$120,920	\$1,266,900	\$259,720	\$24,375	\$89,680	\$2,000
								\$375,775
								\$1,642,675
Prices based on 1964 level								
								Date February 1964
								128,075

TABLE 3 - STRUCTURE DATA

Montpelier Creek Watershed, Idaho

Item	Unit	Structure Dam
Drainage Area	Sq. Mile	27.5
Storage Capacity		
Sediment	Ac. Ft.	210
Floodwater	Ac. Ft.	3,840
Water Supply <u>2/</u>	Ac. Ft.	3,840
Total	Ac. Ft.	4,050
Between High & Low Stages	Ac. Ft.	-
Surface Area		
Sediment Pool	Acres	24
Floodwater Pool	Acres	131
Water Supply Pool	Acres	131
Volume of Fill	Cu. Yds.	553,100
Elevation Top of Dam	Ft.	6,525
Maximum Height of Dam	Ft.	82
Emergency Spillway		
Crest Elevation	Ft.	6,514.5
Bottom Width	Ft.	25.0
Type		Concrete
Percent Chance of Use		1.0
Ave. Curve No - Cond. II		61
Emergency Spillway Hydrograph		
Storm Rainfall (8 hr)	In.	4.4
Runoff	In.	1.02
Velocity of flow <u>1/</u> (v)	Ft/Sec.	13
Discharge Rate <u>1/</u>	cfs.	1,650
Max. W.S. Elevation <u>1/</u>	Ft.	6,519.2
Freeboard Hydrograph		
Storm Rainfall (8 hr)	In.	8.9
Storm Runoff	In.	4.39
Velocity of flow (v _c) <u>1</u>	Ft/Sec.	20.5
Discharge Rate <u>1/</u>	cfs.	6,650
Maximum W.S. - Elevation <u>1/</u>	Ft.	6,525
Principle Spillway		
Capacity low stage	cfs.	215
Capacity Equivalents		
Sediment Vol.	In.	0.143
Detention Vol.	Inc	2.62
Spillway Storage	Inc.	0.99
Class Structure		C

1/ Maximum during passage of hydrograph2/ Irrigation StorageDate February, 1964

TABLE 3A - STRUCTURE DATA

CHANNELS

Montpelier Creek Watershed, Idaho

Channel Designation	Station Numbering for reach		Watershed Area Sq. Mi.	Equivalent Drainage Area Sq. Mi.	Planned Channel Capacity (cfs)	Average Bottom Width (ft)	Average Side Slope	Average Depth (ft)	Average Grade Pct.	Average Velocity in Channel (ft/sec)	Volume of Excavation (1000 cu yds)
	Sta. (100 ft)	Sta. (100 ft)									
No. Canal	0+00	80+40			60	6	1½:1	2.7	0.1	2.25	16.1
" "	80+40	157+40			15	3	1½:1	1.7	0.1	1.60	11.4
So. Canal	0+00	85+00			15	3	1½:1	1.6	0.125	1.75	8.5
No. Drain	0+85	13+50	1.25		60	4.5	0	1.8 <u>1</u> /	4.3	15.2 <u>2</u> /	0.8
" "	13+50	34+65	2.9	0.2	110	7.0	1½:1	2.6	0.525	3.89	4.2
" "	35+40	65+00	3.5	1.2	110	7.0	1½:1	2.9	0.33	3.32	6.2
" "	65+85	117+50	5.4	2.5	110	7.0	1½:1	2.9	0.35	3.50	13.2
" "	117+50	171+00	Broad shallow swamp approx. 1/2 miles in diameter								
" "	171+00	187+25	6.0	3.0	110	14.0	1½:1	3.0	0.1	2.0	9.2
Diversion	0+00	60+00	1.25		40	15.0	4:1	0.8	1.5	3.5	3.0
Channel Imp. (Pipeline)	64+95	101+45	55		110	48" dia.			0.6		1.9

1/ Critical depth - flow is super critical2/ Maximum velocity in concrete chute

Date February 1964

TABLE 4 - ANNUAL COST

Montpelier Creek Watershed, Idaho

	Amortization of Installation Cost <u>2/</u>	Operation and Maintenance Cost <u>1/</u>	Total
Multiple-Purpose Reservoir and Distribution System	\$44,435	\$ 7,445	\$51,880
Diversion and Multiple-Purpose Channel	2,915	2,910	5,825
Stream Channel Improvement	4,055	1,875	5,930
Debris Basin	585	425	1,010
GRAND TOTAL	\$51,990	\$12,655	\$64,645

1/ Price base - long term

2/ All structural measures are amortized for 100 years @3%

Date February 1964

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Montpelier Creek Watershed, Idaho

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	\$18,090	\$1,230	\$16,860
Other Agricultural	800	60	740
Non-agricultural	<u>10,070</u>	<u>50</u>	<u>10,020</u>
Sub-total	\$28,960	\$1,340	\$27,620
Sediment			
Crop and Pasture	\$ 2,000	\$ 130	\$ 1,870
Other Agricultural	1,820	130	1,690
Non-agricultural	<u>2,320</u>	<u>10</u>	<u>2,310</u>
Sub-total	\$ 6,140	\$ 270	\$ 5,870
Indirect	\$ 5,050	\$ 230	\$ 4,820
Total	\$40,150	\$1,840	\$38,310

1/ Price base - Long term

Date February 1964

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Montpelier Creek Watershed, Idaho(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS							Average Annual Cost	Benefits Cost Ratio
	Flood Prevention	Agr. Water Management				Incidental Recreation	Total		
	Damage Reduction	Intensive Land Use	Irrigation	Drainage					
Stream Channel Improvement	\$ 6,550						\$ 6,550	\$ 5,930	1.1 to 1
Multiple-Purpose Reservoir & Distribution System	25,925	\$25,396	\$36,575			\$6,500	94,396	51,880	1.8 to 1
Diversion & Multiple-Purpose Channel	4,080	6,080		\$6,193			16,353	5,825	2.8 to 1
Debris Basin	545	720					1,265	1,010	1.2 to 1
GRAND TOTAL	\$37,100 _{2/}	\$32,196	\$36,575	\$6,193		\$6,500	\$118,564	\$64,645	1.8 to 1

1/ Price base - costs - current prices Benefits - long term prices2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$1,210 annually.Date February 1964

INVESTIGATIONS & ANALYSES

Project Formulation

Field investigations made in connection with the preparation of this work plan were planned jointly by the participating agencies and sponsors and carried out to determine the effects of the land treatment and structural program on the watershed problems.

Choice of measures was based on an inventory of physical and economic conditions within and affecting the watershed. Studies of soil, geology, sedimentation and hydrology, combined with appraisals of water use and need, provided the background for the selection of the remedial measures. Alternatives were tested as to cost and benefit with the most favorable relationship determining the inclusion as a project measure.

Land treatment measures were based on the needs of the watershed as indicated by range, cover and soil surveys conducted by the Forest Service and the Soil Conservation Service.

Land treatment measures proposed for installation on the irrigated lands are limited to those required to attain full benefit from the structural measures. The going program is based upon a projection of current application rates. The accelerated program is based upon needed acceleration of the going program adjusted to the application rate anticipated with the project.

Structural measures proposed for construction for flood protection will afford the City of Montpelier and agricultural lands west of the city with protection from a 1% event. Agricultural lands north of Montpelier will be provided varying protection of from 1% to 10% events.

Structural measures proposed for agricultural water management aim at optimum utilization of the 80 percent chance yield of the watershed for full season irrigation and a distribution system capable of efficiently delivering the amount of water needed by irrigated crops.

Soil & Cover Inventory

Soils in the irrigated valley portion of the watershed were divided into three treatment groups based on texture, depth and moisture holding capacity. These include Group I, well drained, medium to moderately fine textured soils more than 36" deep. Group II, well drained, gravelly or non-gravelly medium to moderately fine textured soils 20-36" deep. Group III, deep, imperfectly and poorly drained soils, moderately coarse to moderately fine textured.

Dryland soils in the watershed are divided into two treatment groups:

Group I Well drained, medium to moderately fine textured soils more than 36" deep - good moisture holding capacity on slopes from 0-20%.

Group II Well drained gravelly or non-gravelly, medium to moderately fine textured soils - 20-36" deep moisture holding capacity good - slopes vary from 0-4%.

Range land soils are predominantly shallow and stony with dominant slopes to the south and west. These slopes are cut by secondary drainages that break the terrain which results in the inclusion of small segments of steep north and east slopes.

Private range lands were classified by range sites. Six range sites were identified as follows: shallow stony south slope, shallow stony north slope, loamy upland, stony upland, gravelly upland and creek bottom. Range condition on these sites varies from poor to good with forage production usually less than the potential.

National Forest lands were surveyed by the Forest Service and vegetative and soil resources were inventoried. Nine hydrologic condition classes were recognized. These served as a basis for determining hydrologic condition on the National Forest lands in the watershed and determining needed treatment measures. National Forest lands occupy an area that ranges from 6150 to 9400 feet in elevation. The lower portions consist of gentle to fairly steep terrain with predominant sage and grass vegetation. The middle elevations are of steeper slopes and are characterized by aspen and conifer timber on the north exposures. The high canyon heads and ridge tops are steep with exposed rock and sparse vegetation. Grazing of these high areas by sheep has greatly contributed to the active gully patterns present.

Geology

Dam & Reservoir Site

Topography and General Geology

Topographic expression of the proposed dam and reservoir site consists of a narrow north-south trending shoestring valley ranging from some 400 to 600 feet in width and generally bounded by steep, more or less uniform slopes formed of mountain ridges which rise to an elevation several hundred feet above the valley floor.

Geologically the site lies within the complex thrust belt area of southeastern Idaho characterized by close folding, thrust faulting and extreme crustal shortening. The rocks underlying the site area consist predominantly of folded and overturned limestone, sandstone, and shale strata comprising the Higham, Timothy, and Wood formations of Triassic age and the Nugget and Twin Creek formations of Jurassic age.

Methods & Scope of Investigations

Surface geology of the dam and reservoir site area was mapped on a scale of 660 feet per inch using aerial photos as a base to provide a basis for layout of preliminary exploratory drill holes and to facilitate interpretation of subsurface geologic conditions in terms of foundation imperfections, possible treatment, and design requirements.

Six (6) core drill holes ranging from approximately 45 to 140 feet in depth were put down on a modified site selection basis to determine optimum site conditions within a roughly one-quarter to one-half mile reach of the valley involving two possible dam sites (see plan of explorations). A downstream

site appeared to be most favorable from the viewpoint of topography and length of dam required whereas an alternate upstream site appeared to be the most favorable geologically. Core drilling included disturbed representative sampling of overburden materials utilizing the standard penetration test and extensive hydraulic pressure testing of foundation bedrock to determine extent of possible pervious zones, foundation permeability, and to permit evaluation of possible detrimental underseepage which would require special foundation treatment. Foundation drilling was supplemented by seven (7) backhoe test pits permitting inplace examination of foundation materials to depths up to approximately 14 feet.

Based on surface geology and preliminary subsurface investigations, an alternate site upstream was tentatively selected as probably being the most feasible dam site.

Return flow possibilities below the dam and reservoir site as related to water losses from underseepage at the dam and from reservoir leakage were evaluated based on stream flow measurement and hydrogeologic considerations.

The magnitude of reservoir leakage to be expected was evaluated quantitatively by analog model analysis supplemented by inplace inspection of blanket-ing overburden materials and their probable effectiveness. Underseepage at the dam was estimated from hydraulic pressure test data.

Foundation Geology

Foundation materials consist of a gravelly overburden of variable depth over badly sheared and fractured bedrock formed of limestone on the left (east) abutment, shale and sandstone beds beneath the valley floor and sandstone on the right (west) abutment. (See Geologic section). Foundation bedrock strikes N.12°W to N.6°E with west dips ranging from 86° to 26° to form an angle of 80 to 82 degrees with the axis of the proposed dam. The foundation strata underlying the site in part forms the east flank of a north-south trending anticline which is overturned to the east with its axial plane dipping to the west.

Overburden materials comprised of silt and rock fragments form a thin discontinuous cover on the left abutment but provide a thick effective impervious blanket on the right abutment.

The overburden cover flooring the valley bottom ranges from roughly 20 to 40 feet in thickness and contains interfingering layers of predominantly silt, gravelly silt, and clean gravels.

A shallow well-defined ground water table exists in the foundation area and beneath the abutments affording a minimum cross-sectional area for leakage to occur.

Foundation Problems and Proposed Treatment

The major foundation problem anticipated is stability relative to behavior both under load and under the effects of percolating water and hydrostatic pressure. Foundation materials of low shear strength may require flattening of embankment slopes. Permeable gravel strata will require a cutoff to

bedrock for positive control of underseepage. Proposed treatment to control movement of water and buildup of excessive hydrostatic pressure in the permeable limestone strata underlying the left abutment will include grouting and possible upstream blanketing.

Estimated water loss from underseepage through the foundation rock proper and around the abutments is negligible based on an analysis of preliminary pressure test data.

Geology of Reservoir Area

Geology of the reservoir basin is essentially like that of the dam site. The underlying rocks are part of the east flank of a major north-south trending anticline overturned to the east and consist of badly sheared and broken limestone, shale, and sandstone beds striking generally north-south roughly parallel with the axis of the valley and dipping from about 50 to 65 degrees west. The west rim of the reservoir is underlain by sandstone strata dipping westerly away from the reservoir whereas the east rim is underlain by limestone strata dipping westerly into the reservoir and formed of alternating beds of massive broken ledge rock and thin-bedded highly sheared shaly members. The reservoir floor is underlain from east to west by limestone, shale and sandstone strata.

Reservoir Leakage Conditions

Ground-water conditions characterized by a high water table and ground-water underflow from highland areas as locally indicated by spring discharge are favorable from the viewpoint of possible reservoir leakage. Based on limited pressure test data and overburden cover conditions, the reservoir basin is considered to be reasonably tight with the possible exception of the east reservoir rim which is locally underlain by permeable limestone strata. A preliminary estimate of leakage from the east rim based on an analog model analysis using pressure test data is 2 cfs. The combined loss of roughly 3 cfs from leakage through the reservoir rim and underseepage beneath the dam does not appear to be a problem from the viewpoint of project use considering return flow possibilities downstream as indicated by stream loss measurements and hydrogeologic considerations.

Sources of Construction Materials

Impervious borrow materials -

Preliminary estimates based on exploratory test pits indicate that there are adequate quantities of impervious borrow available within three-quarters of a mile of the site. This material will come from along the west reservoir rim.

Riprap and Rock-fill materials -

Durable sandstone rock suitable for riprap and rockfill is available in quantity from a ridge spur on the west reservoir rim approximately one-half mile distance from the site. Sandstone rock from spillway excavation across the right abutment and gravelly overburden from cutoff trench excavation can be used to advantage as random fill.

Filter Materials -

There does not appear to be a close source of borrow suitable for filter materials. The bulk of the 33,100 cu. yds. of filter materials estimated to be required will have to be hauled in from an outside source.

Additional Investigations Needed

Additional foundation exploration needed includes that downstream to fully evaluate subsurface geologic features at the downstream site relative to final site selection. Assuming equally good foundation conditions a substantial savings would be possible by building on the lower site based on the shorter length of dam required and a shallower depth to rock for a cutoff.

A tentative outline of the extent and type of investigations needed for final site selection and specifications - design entails an estimated 15 core drill holes with an aggregate footage of 820 feet including one (1) shallow boring in the east reservoir rim for permeability evaluations. Foundation drilling would include disturbed and undisturbed sampling of overburden materials for purposes of evaluating compression and shear, possibly pump-in tests in overburden, and Nx core drilling and pressure testing of foundation rock.

Tentative estimates for detailed borrow investigations include additional pits and auger borings to firm up quantities and to determine depth of shovel cut and distribution of materials in the embankment.

Test drilling and "shooting" of the proposed rock source for riprap and rock fill will be required to determine quantities and the quality and size of the material.

Additional investigations also will be needed to locate a source of suitable filter materials.

Estimated cost of the detailed foundation and borrow investigations is \$15,755.

Debris Basin Site

Scope of Investigations

Preliminary feasibility investigations at this site were limited to an examination of surface geology to determine apparent site conditions in terms of the probable extent and type of subsurface investigation needed for final design and to pinpoint possible features which might limit site feasibility.

Geology

Geologically the site occupies a comparatively shallow V-shaped arroyo with moderately gentle slopes underlain by uniform silts on the abutments and gravelly stream wash deposits in the flattened channel section. Rock exposed upstream suggests that limestone bedrock probably underlies the site at a depth of 10 feet or more. No particular problems are anticipated at

this site.

Preliminary reconnaissance indicates that suitable borrow materials probably are readily available.

Additional Investigations

Considering probable subsurface conditions, foundation test pits permitting inplace inspection and sampling of oberburden materials should provide adequate information for final design purposes. The borrow inventory will include pits supplemented by auger borings to firm up quantities and the type of materials available.

Estimated cost of foundation and borrow investigations for this site is \$500. Total cost for the main dam and the debris basin is \$16,355.

Sedimentation

Methods of Determining Rates of Gross Erosion

Estimated gross erosion on the watershed area above the proposed reservoir site was developed by the Forest Service (1963) 1/ from field data involving on-site measurements of soil horizon depth, gully cross-sectional area, length and frequency, and a relative classification of sheet erosion supplemented by measurements made on air photos. Accelerated erosion was assumed to be coincident with the advent of grazing and timber harvest following settlement of the area roughly 100 years ago. Estimates of original soil depths at the time of settlement were primarily made on the basis of soil remnants for each hydrologic type area. From the relationship between measured erosion and the time interval involved, the average annual gross erosion rate is estimated to be .39 ac. ft. per square mile per year.

Gross erosion on the dryland area was estimated from an evaluation of annual land damage reports, field observations and the relationships between inherent soil erodibility, runoff characteristics, and the controlling influence of frozen ground. From these relationships, average annual gross erosion on the dryland is estimated to be 1.8 ac. ft. per square mile per year or approximately 5 tons per acre per year.

Sediment Yields

Annual sediment yields on the subwatershed areas under present conditions are estimated to range from 7,950 tons per year on the Montpelier Creek drainage to 11,000 tons per year for the combined dryland areas including the approximately five and one-half square miles of adjoining range lands. Considering drainage size and shape, channel density, and access of entrained sediment to channels, sediment yield on the dryland area is estimated to be 70 percent of gross erosion. Sediment yield for the Montpelier Creek drainage was derived from application of sediment survey data from a small fish

1/ Hydrologic analysis made by Forest Service, Montpelier Watershed, PL 566 Project, July 1963.

rearing pond located in the watershed with adjustment being made for differences in sediment yield expected between drainage areas of markedly different size.

Land Treatment Program Effects on Sediment Yields

The estimated effect of land treatment on gross erosion and sediment yields is shown in the table below.

Effect of Land Treatment on Sediment Yield Montpelier Creek Watershed, Idaho				
Subwatershed	Sediment Yield		Reduction in Sediment	
	Present Condition	Future Condition :w/Land Treatment (Tons/Yr.)	Yield by Land Treatment (Tons/Yr.)	(Percent)
Montpelier Creek <u>1/</u>	7,950	7,155	795	10
Dryland <u>2/</u>	11,000	4,930	7,070	64

Land treatment on Forest lands in the upper portion of the watershed, which forms approximately one-half of the contributing watershed area, is estimated to reduce gross erosion by 32 percent. Considering the nature, type, and extent of accelerated erosion relative to topography and channelization and type of treatment planned, it is estimated that sediment yield from this area will be reduced by 20 percent. From these relationships, and including the sediment yield from untreated lands making up the lower half of the watershed area, it is estimated that sediment yield from the combined Montpelier Creek drainage areas will be reduced by 10 percent.

It is estimated that the present level of protection on dryland under present conditions is 40 percent of the maximum level of protection obtainable with 80 percent being the estimated maximum level of protection possible under future conditions with land treatment. Thus the present program is assumed to be roughly 30 percent effective. On this basis and considering the total reduction in annual gross erosion possible with the estimated maximum protection level obtainable (80%) as compared to 100 percent non-treated land and including contributions of sediment from adjoining untreated range lands, reduction in sediment yield by land treatment is estimated to be 64 percent.

1/ Includes entire drainage area (55.6 sq. mi.) to canyon mouth just above town of Montpelier.

2/ Includes approximately 3,600 acres of adjoining mountainous range lands for a total contributing area of 9.35 sq. mi.

Effect of Land Treatment on Downstream Sediment Damage

Reduction in sediment damages from land treatment on dryland is estimated at one half of the reduction in sediment yield (64%) or 32 percent because of the opportunity for runoff water to pick up a new load along the lower slopes of the dryland area as sediment concentrations are reduced upslope by land treatment. Reduction in downstream sediment damages from land treatment on Montpelier Creek is assumed to be equal to the reduction in total sediment yield, or 10 percent.

Sediment Storage Requirements in Reservoir Sites

Estimated sediment storage requirements for the proposed reservoir site and debris basin in the Montpelier Watershed are given in the table below.

Estimated Sediment Storage Requirements					
Subwatershed	Drainage Area (sq. mile)	Avg. Annual	Sediment	Sediment Accumulating	
		Yield	Rate	in 100 years	
		Initial 20	Final 80	(tons)	(Ac. Ft.)
		<u>yr. period</u>	<u>yr. period</u>		
		Tons / Sq. Mi/ Year			
Montpelier Creek (above reservoir site)	27.5	166	133 <u>1/</u>	364,705 <u>3/</u>	210
South Wash Debris Basin (dryland)	.85		644 <u>2/</u>	41,055 <u>4/</u>	23.6

Estimated sediment storage requirement for the reservoir on Montpelier Creek was adjusted for a 95 percent trap efficiency based on spillway discharge.

Considering the fine texture of incoming sediment, shape of the basin, and operation, it is estimated that all sediment delivered to the South Wash debris basin will deposit below spillway level or pass through. Trap efficiency involving spillway discharge was not considered because of the infrequent use of the emergency spillway. The debris basin will be provided with

1/ Land treatment program is estimated to be fully effective at end of initial 20 year project period with a 20% reduction in average annual yield rate.

2/ Total project period of 100 years.

3/ Adjusted for 95% trap efficiency.

4/ Adjusted for 75% trap efficiency.

an ungated outlet, size and location of which will allow low flows to pass without pending. Size of the basin (7.25 ac. ft.) will permit the reservoir to empty before the finest fractions have opportunity to settle out. Considering these factors, it is estimated that 25 percent of the sediment entering the basin will pass through the ungated outlet and the sediment storage requirements has been adjusted for an estimated 75 percent trap efficiency.

Engineering Investigations

Flood Prevention

Dam

For purposes of investigations and analyses the watershed of Montpelier Creek is divided into two (2) sub-areas. The sub-area above the dam site drains 27.5 square miles and the sub-area below the dam site drains approximately 27.5 square miles above the City of Montpelier. Under project conditions the low area, uncontrolled by the dam, will contribute an estimated peak flow of 150 cubic feet per second at the mouth of the canyon near the eastern boundary of the City. To provide the agreed upon 1% protection for the city, channels must be provided to carry this quantity through or around the City.

The minimum flood detention capacity in the reservoir is that required to reduce the peak flows from the one percent (1%) Spring flood event to the capacity of the channels required for the Winter flood event (150 c.f.s.). Additional storage capacity would increase the level of protection provided but would not reduce the channel sizes required. This flood detention capacity was found to be 3800 acre feet, or approximately that to be provided for agricultural water management. The total capacity provided for A.W.M. will be available for flood prevention, therefore, the level of flood protection for this type event slightly exceeds the one percent (1%) level agreed upon.

Storage capacity and fill volumes are based upon topographic surveys of the area. Foundations and borrow investigations are described in the Geology section of this plan. Water yields and peak flows are discussed in the Hydrology section of this plan.

Channel Improvement

The capacity of the present channel of Montpelier Creek is approximately 100 C.F.S. when free of ice and snow. To assure an ice free channel during the Winter runoff will require drying up the channel during freezing weather or enclosing it to prevent ice formation. The design of a channel to carry peak flows with ice present involves the uncertainty of the thickness or quantity of ice, prevention of ice jams, etc. It is further complicated by the elevation of the U. P. Railroad yard in relation to that of the Bear River and ground surface which prevents free flow from the culvert at that point. This type channel is considered impractical.

Three general methods of providing the required channels were considered. These are: 1. Installing a small pipeline to carry the low winter flows and leave the open channel ice free. Removal of snow from the channel and prevention of ice jams at numerous obstructions required high operating expense. 2. Enclosing of the channel through the densely populated area to prevent ice formation. This method requires prevention of ice jams at the inlet only, operation and maintenance costs are low. 3. Diverting a flood through a flood channel north of town. This method would provide a flood channel relatively free of ice by using the existing channel during freezing weather. Snow removal from the channel and normal maintenance of unlined earth channels make operation and maintenance costs high.

A combination of the last two methods enclosing the channel and partial diversion was found to have the least average annual cost for the combination of structural measures. The combination chosen consists of diverting approximately 60 cubic feet of the one percent (1%) flood peaks through the North Canal to the North Drain then to the Bear River. The remaining flow of 110 cubic feet per second will be carried through the densely populated area of the city in a 48 inch diameter concrete pipeline to the existing channel west of the U. P. Railroad yards and to the river.

This alternate involves utilizing the upper 8,040 feet of the North Canal as a multiple purpose channel up to the capacity required for agricultural water management purposes.

The annual costs of the alternate methods analysed are:

1. Diversion and 48" pipeline = \$14,115
2. Total flow enclosed (54" pipeline) = \$16,175
3. Ice free channel and 18" pipeline = \$15,955
4. Diversion of total flood flow with winter flow in Natural Channel \$14,265

In computing the above costs, annual operation and maintenance of the open channels was assumed to equal five percent (5%) of the construction cost because of the need for weed control, ice and snow removal, and normal replacement of control structures. The annual operation and maintenance of the pipelines was assumed to equal one and one-half percent (1½%) of the construction cost because of the need to remove ice at the inlets and outlets and to make normal replacements of structures. In the first three alternates the size of the North Canal and North Drain must be maintained for irrigation purposes and to care for the runoff from Joe's Gap and the other short steep draws above the canal or the degree of protection will decrease. In the fourth alternate the existing stream channel must be maintained to carry the normal flows during freezing weather to maintain the North Canal and North Drains free of major ice formations. With the normal winter flows in an open channel a hazard of local flooding exists due to ice forming and blocking channel particularly at the railroad culvert where submerged flow occurs with even the smallest flows.

The capacity of the stream channel and canals are based upon profile and typical cross section surveys.

Diverson Channel

A frontal area extending north from Montpelier Creek to include the Joe's Gap drainage contributes flood water and sediment damages to the irrigation distribution system, highway, and agricultural lands. Field investigations indicate that the waters from this area enter and leave the damaged area at several points that change from season to season depending on snow cover, snow drifts, cultural treatment and possibly other factors. The combined peak flows of these small varying drainage areas is estimated for the various frequencies as 1% = 70 c.f.s.; 5% = 43 c.f.s.; 10% = 34 c.f.s.; and 20% = 25 c.f.s. Existing topographic surveys indicate most of the runoff from this area can be collected by approximately 6,000 feet of diversion channel and approximately 2,600 feet of low dike above the canal and admitted into the North Canal at or above the head of the North Drain at a controlled point and then into the Bear River.

Hydrologic investigations indicate the peak flow from such a system will equal approximately 40 c.f.s. during a 1% chance event.

The soils in the approximate location of the diversion are predominantly silts and sandy silts.

North Drain

For flood prevention purposes a method of conducting the runoff, from the frontal area north of Montpelier Creek and any water diverted from Montpelier Creek, to the Bear River must be provided. Routing of the hydrographs from the individual areas indicate that no two areas will peak at the same time. The maximum flow reaching the head of the North Drain will be approximately 60 cubic feet per second during a 1% chance event. To prevent the destruction of the heading and chute this capacity must be provided. The peak flow near the crossing of Highway U.S. 30 N. is estimated to be approximately 110 c.f.s. This capacity will be maintained to the Bear River. Near the railroad crossing the level of protection provided will be approximately 5%.

The soils vary from sandy silt, and gravels to heavy silty clays. From the lower end of the chute to the river the channel will be below the natural water table so it will become vegetated in a short time. The location and capacity of the north drain are based on a strip topographic survey along the approximate low point of a draw extending from east of U.S. Highway 30 N. to the railroad crossing there along a property line to the closest point of the Bear River.

Debris Basin

The small unnamed draw near the south edge of the city drains approximately 0.85 square mile of low land most of which is cropped as dry land. Serious runoff from this area occurs only during the Winter runoff event. The height of fill of the debris basin is limited by the height of the right abutment and is influenced by the location of a farmstead. Sediment production during the runoff period is high. Peak flow of a 1% chance event is estimated as 54 c.f.s. Existing channels below the mouth of the canyon will carry 13 c.f.s. or more with only minor improvements to remove obstructions.

The storage capacity and fill quantities are based upon a topographic survey of the site area.

Agricultural Water Management

Distribution System

Water supplies are shown and discussed in the Hydrology section of this plan.

Present irrigation methods range from sprinkler to wild flooding. Very little of the land has been leveled. Corrugation and border methods of irrigation are not used in this area. Field efficiencies vary from possibly 60% to less than 20%. The overall field efficiency is estimated as 25% by Soil Conservation Service technicians and the Irrigation Company Directors. On-farm irrigation system losses vary from near zero for those farms using sprinkler systems or where the ditches are excavated in heavy textured soils to about 30 percent where long ditches are excavated into sands and gravel. The average loss is estimated as 10 percent. Water is delivered on a rotation basis. The normal size of irrigation stream delivered is approximately 5 c.f.s. During the late part of the irrigation season when stream flow is low all of the ditches and canals will become dry between rotations.

Based on a limited number of current meter measurements and ponding tests the present canal losses are estimated as 15% including the water lost by repeated rewetting of the canals.

With project conditions the method of delivery will change, late season water supplies will be greater and drying up of canals will be reduced. Future canal losses are estimated as 10 percent, and on-farm ditch losses as 10 percent.

Irrigation requirements were computed by the Modified Blainey-Criddle method for present condition and crop pattern, and for "with project" condition and crop pattern.

Crop distribution and irrigation season for the two conditions are shown in the following table:

Crop	Percent		Irrigation Season
	Present Condition	With Project Condition	
Fall planted wheat	2	7	May 16 to August 1
Spring planted grains	12	27	May to August
Alfalfa	40	39	May through September
Pasture	10	27	May to October 15
Non-irrigated Cropland	<u>36</u> <u>1/</u>	<u> </u>	
Total	100	100	

1/ Non-irrigated cropland is composed of 5% wheat, 15% barley, 10% pasture, and 6% summer fallow.

Weighted irrigation requirements for a composite acre and the acres which an 80% chance runoff will fully supply are shown by month in the following table for present conditions and crops:

	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>
Consumptive Use - In.	0.67	2.54	6.07	4.14	1.63	0.03
Field Eff.	25%	25%	25%	25%	25%	25%
Field Require.-Inc.	2.68	10.20	24.30	16.55	6.52	0.12
Farm System Eff.	90%	90%	90%	90%	90%	90%
Turnout Req. - In.	2.98	11.30	27.0	18.4	7.25	0.13
Canal Eff.	85%	85%	85%	85%	85%	85%
Diversion Demand-In.	3.5	13.3	31.8	21.4	8.55	0.15
Diversion Demand-Ft.	0.29	1.12	2.67	1.80	0.72	0.01
Available 80%	2050	2110	1070	640	500	600
Can Supply Ac.	7070	1900	400	355	695	6000

Weighted irrigation requirements for a composite acre under "with project condition and crop distribution" are shown in the following table. Canal efficiency was estimated as 90% and field efficiency as 55%, with soil moisture at the end of the irrigation season depleted by 2 inches.

<u>Item</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>
Net Irrig. Req. Composit Ac. in Inches	0.90	2.66	5.54	2.81	0.07
Field Efficiency percent	55	55	55	55	55
Requirement to Field-In.	1.64	4.84	10.07	5.11	0.13
Farm System Efficiency %	90	90	90	90	90
Delivery at Turnout.-In.	1.82	5.38	11.19	5.67	0.14
Canal Efficiency Percent	90	90	90	90	90
Diversion Requirement-In.	2.02	5.98	12.43	6.30	0.16
Diversion Requirement-Ft.	0.17	0.50	1.04	0.52	0.01
Season Diversion per acre in Ft.	2.24				

Comparing the diversion requirements to the anticipated yield of an 80 percent chance runoff event indicates that 3,840 acre feet of irrigation storage will be required to fully irrigate 3,400 acres of land. Storage capacity of 210 acre feet is provided for sediment during 100 years of the evaluation period. The comparison provides for the assumptions of normal precipitation at Montpelier, evaporation rate at Lifton, and a maximum seepage rate of 3 cubic feet per second. The analysis indicates a spill of approximately 450 acre feet during May and June. The assumed seepage rate is based upon the limited foundation investigation and is probably on the low side. Additional refinement is not justified, however, at this time.

The diversion required to irrigate 3,400 acres in acre feet is: May 578; June 1,700; July 3,536; August 1,768, and September 34.

North Drain

North of Montpelier approximately 1,920 acres of agricultural lands are affected by high water table or poor surface drainage. Topography and the relative elevation of the affected lands and the Bear River limit the depth of outlet drains to approximately 3.0 feet without pumping drainage water. Lowering the water table more than 3.0 feet would adversely affect adjacent sub-irrigated lands.

A drain with a minimum depth of approximately 3.0 feet along the alignment of the approximate low point in a draw will provide sub-surface drainage to approximately 320 acres and will provide a drainage outlet for an additional 1,600 acres.

It was found feasible to accomplish both the drainage and flood prevention objectives with one channel.

Engineering Designs

Dam

Borrow investigations indicate adequate quantities of materials suitable for both an impermeable core and permeable shells are locally available but that filter materials may have to be imported from the Bear River flats. A zoned type of fill was selected because this type of fill requires the minimum quantities of fill material for stability under all conditions of construction and operation. Stability analyses, by the Swedish Circle Method, indicate fill slopes of $2\frac{1}{2}$ to 1 on the upstream face and 2 to 1 on the downstream face will be stable and that the foundation will support such a fill.

Two possible damsite locations approximately $\frac{1}{4}$ mile apart were considered. Surface investigations and limited subsurface investigations indicate the upper site may be geologically more suitable than the lower site. The lower site will require approximately $\frac{2}{3}$ as much fill materials as the upper site. Designs and cost estimates presented in this plan are based on the upper site. Additional foundation investigations will be needed in the design stage to pinpoint the dam location and refine cost estimates. This is a high hazard, class C dam, involving possible loss of life and destruction of important utilities in case of failure.

Spillways for the dam will be restricted to a gated outlet conduit and a concrete lined emergency spillway.

The size and capacity of the outlet conduit was selected to permit the passage of the required irrigation flow at low stages of operation, to handle flood flows and to permit passage of normal stream flows during the construction period without the requirement of a high diversion dam.

The size and capacity of the emergency spillway was selected by routing the spillway hydrograph through the reservoir starting with the water level equal to the emergency spillway crest. Using a trapizoidal rounded weir box inlet with a base width of 25.0 feet the peak discharge equals 1,650 cubic feet per second with a maximum stage of 4.5 feet above the spillway crest. Concrete portions of the emergency spillway are designed to carry 2,400 cfs without overtopping the concrete.

The freeboard requirement was set by routing the freeboard hydrograph through the reservoir starting the routing at the level of the water surface after ten days of draw down using the average rate of release required for irrigation purposes. This routing indicates a maximum stage of 10.5 feet. Using 10.5 feet of spillway depth leaves 6.0 feet of residue freeboard when passing the spillway hydrograph. This is adequate considering probable frost depth and wave action.

The proposed dam will require 108,500 cubic yards of impermeable core material, 33,100 cubic yards of filter material, 309,400 cubic yards of shell material, 93,000 cubic yards of excavation and impermeable material in the cutoff trench, and 9,100 cubic yards of blanket material to reduce seepage through the left abutment.

The total installation cost is estimated as \$1,338,000. The annual operation and maintenance costs are estimated as \$4,970.

Channels

North Canal

The desired capacity of the North Canal varies from 60 c.f.s. at the upper end to 15 c.f.s. at the lower end. This capacity will permit the delivery of water to the individual delivery points on a semi-demand basis. The average slope of the channel is approximately 0.001 foot per foot. The hydraulic elements of the canal are:

Sta. 0+00

Side slopes $1\frac{1}{2}:1$, $n=0.03$, $b=6.0$ ft., $d=2.7$ ft., $a=27.15$ sq. ft., $r=1.72$, $v=2.25$ ft./sec., $Q=61.2$ c.f.s.

Sta. 157+170

Side slopes $1\frac{1}{2}:1$, $n=0.03$, $b=3.0$ ft., $d=1.7$ ft., $a=9.45$ sq. ft., $r=1.04$, $v=1.60$ ft./sec., $Q=16.6$ c.f.s.

For flood prevention purposes the upper 8,040 feet of this channel must carry 60 c.f.s. There will frequently be partial blocking of the channel by ice and snow during the period when flood flows occur. Using an "n" factor of 0.03 the channel will carry 40 c.f.s. when approximately 1/3 blocked. The estimated annual operation and maintenance cost includes the cost of snow removal and combating ice jams.

The estimated installation cost is \$42,400. The estimated annual operation and maintenance cost is \$1,480.

Irrigation Canal

The remainder of the irrigation distribution system requires the rehabilitation and improvement of 8,500 feet of canal and the installation of approximately 23 water control structures. The hydraulic elements of the channel are: $b=3.0$ ft., $d=1.6$ ft., $s:s=1\frac{1}{2}:1$, $s=0.00125$, $v=1.75$ ft./sec., $Q=15.0$ c.f.s. The water control structures consist of turn outs and measuring devices to control and measure the delivery of water.

The estimated installation cost is \$23,600. The estimated annual operation and maintenance is \$995.

Pipe Line

Pipe capacities were computed using $n=0.012$. Bend losses were computed using the formula:

$$K_5 = 1 - \frac{(90 - \text{deflection in degrees})^2}{90}$$

The K_5 loss for a 90° bend was determined by methods commonly used in engineering practice.

Using the present channel alignment, with only minor straightening, a pipeline 3,650 feet long will extend from U. S. Highway 30N to west of the railroad yards. A 42 inch concrete pipeline will carry approximately 75 cubic feet per second, a 48 inch concrete pipeline approximately 110 cubic feet per second, and a 54 inch concrete pipeline approximately 150 cubic feet per second. Man holes are planned for all bends of over 70° .

The 48 inch pipeline, which approximately utilizes the capacity of the North Canal and North Drain, was found to have the lowest annual cost.

The estimated installation cost is \$128,075. The estimated annual operation and maintenance cost is \$1,875.

Diversion Channel

The diversion channel will be located by starting from the heading of the North Drain and backed in on a slope of approximately 1.5 percent to intersect the outlet channel of Joe's Gap. The hydraulic elements are $b=14.0$ ft., $\text{depth}=0.8$ foot, side slopes= 4 to 1 , $a=13.76$ sq. ft., $r=0.67$ using retardance "D", $n=0.04$, $s=0.015\frac{1}{2}$, $v=3.5$. The bottom and sides of the channel will be seeded to a sod forming grass. Soil is a sandy silt. The maximum velocity of 3.5 ft. per sec. is safe after a vegetative cover is established. The estimated installation cost is \$5,500. The estimated annual operation and maintenance cost is \$210.

North Drain

The North Drain consists of a control structure at its junction with the North Canal with a concrete chute or pipeline to lower the flood waters to the low land east of U. S. 30N, a channel from this point to the river and a control structure at the river equipped with flood gates. The chute will have a slope of 4.3 percent, flow will be super-critical. The base width is 4.5 feet, $n=0.015$, then depth at the upper end = 1.8 ft. and at the lower end = 0.875 ft./sec. and the maximum velocity = 15.2 feet per second. $Q=60$ c.f.s.

From the lower end of the chute to the river the capacity is planned to be 110 c.f.s. using $n=0.04$. The slope bottom widths and depth of flow vary. The maximum velocity of 3.89 ft./sec. will be safe in a vegetated channel. The soils vary from sandy silt and gravel to silty clay.

The river control will be of reinforced concrete with 3 flood gates to prevent river water backing into the drainage channel during the river high water period in late summer. Seepage water and surface waste water collected by the drain during the high stage of river flow will pond in the swamp area near the railroad.

The estimated installation cost is \$86,600. The estimated annual operation and maintenance cost is \$2,700.

Debris Basin

The debris basin in the small draw near the south edge of Montpelier is designed to control a 1 percent chance flood event without flow in the emergency spillway. Routing of the 1% hydrograph indicates an ungated principle spillway 18" in diameter will pass the flood with a peak flow of approximately 13.0 c.f.s. at a maximum stage of 5.6. Flood detention at this stage is 4.0 acre feet.

The fill 23 feet high will be of a zoned type construction.

The principle spillway crest elevation is 6,000. The emergency spillway crest elevation is 6,006. This spillway will be grassed except where it is in rock. The sediment storage capacity of 2.75 acre feet will require periodic cleaning approximately every 10 years. The annual operation and maintenance cost is \$425 including cleanouts. The estimated installation cost is \$18,500.

Cost Allocation

Montpelier Creek Watershed includes three multiple-purpose structures. Allocation of costs to purposes were made as shown below.

Dam

	A.W.M	Flood Prevention	Sediment	Flood Prevention Plus Sediment	Total
Capacity	3,840	3,840	210		4,050
Percent of Capacity	94.8	94.8	5.2		100
Percent of Cost	47.4	47.4	5.2	52.6	100
Construction Cost	471,160	471,160	51,680	522,840	994,000
Installation Services	117,550	117,550	12,900	130,450	248,000
Foundation Investigation	7,110	7,110	780	7,890	15,000
Other Costs					
Easment & ROW	1,420	1,420	160	1,580	3,000
Road Relocation	27,020	27,020	2,960	29,980	57,000
Water Rights	475	475	50	525	1,000
Administration of Contracts	9,480	9,480	1,040	10,520	20,000
Installation Cost	634,215	634,215	69,570	703,785	1,338,000

North Canal

Total Installation Cost	\$42,400
Specific Costs for Irrigation	<u>17,660</u>
Joint Costs	\$24,740
Joint Costs allocated 50% Flood Prevention and 50% A.W.M.	

Item	FP	AWM Joint	AWM Specific	Total AWM	Total
Construction Cost	8,640	8,640	12,350	20,990	29,630
Installation Services	2,820	2,820	4,010	6,830	9,650
Other Costs					
Easments & ROW	455	455	650	1,105	1,560
Water Rights	225	225	330	555	780
Administration of Contract	230	230	320	550	780
Installation Services	12,370	12,370	17,660	30,030	42,400

North Drain

Installation Cost of Combined	\$86,600
Specific Costs for Flood Prevention	46,555
Joint Costs	40,045
Installation Cost of Drainage	29,400
Total of Joint & Drainage	69,445
Allocation of Joint Costs to A.W.M.	
$29,400 \div 69,445 = 0.424 = 42.4\%$	

Item	AWM	FP Joint	FP Specific	Total FP	Total
Construction Cost	7,420	10,080	36,500	46,580	54,000
Installation Service	1,855	2,520	9,125	11,645	13,500
ROW	7,550	10,250	200	10,450	18,000
Administration of Contract	<u>155</u>	<u>215</u>	<u>730</u>	<u>945</u>	<u>1,100</u>
Total	16,980	23,065	46,555	69,620	86,600

Hydrology

Basic procedures used in hydrologic investigations are outlined and described in the Soil Conservation Service National Engineering Handbook, Section 4, Hydrology Supplement A (Hydrology Guide).

Hydrologic studies were primarily concerned with: (1) determining the quantity of water that is available for irrigation; (2) determining the volume of storage needed to provide a full supply to the irrigated area in 8 years out of 10; (3) determining the effect of the proposed irrigation storage upon floods; (4) developing a reservoir operation system for utilizing the reservoir for both irrigation and flood control; (5) computing the design hydrographs for the reservoir; (6) determining the characteristics of winter floods from the low-elevation areas; and (7) computing design hydrographs for the multiple-purpose channels.

Other hydraulic and hydrologic investigations concerned with agricultural water management are discussed under a preceding section entitled "Agricultural Water Management Investigation".

Basic Data Available

Climatological Data

Climatological data from two stations were used in the hydrologic studies: Montpelier Ranger Station at elevation 5,943 within the City of Montpelier and Lifton Pumping Station at elevation 5,926 14 miles south of Montpelier. The following published data are available:

Station	Daily precipitation	Daily max-min. temp.	Daily Evap. + wind
Montpelier	1930 to present	1930-1938 + 1948 to present	none
Lifton	1930 to present	1930 to present	1935 to present

Snow Survey Data

Snow survey data are available since 1936 from Slug Creek Divide snow course which is 16 miles north of Montpelier and 7 miles north of the north end of Montpelier Creek Watershed. The elevation of Slug Creek Divide is 7,225. Three new snow courses were installed on the Montpelier Creek Watershed in 1962, but the records are not long enough to be useable at the time of planning. They will become useful to the reservoir operation as more accurate forecasts can be made from their data.

Streamflow Data

Streamflow data are available for two different U. S. Geological Survey gaging stations on Montpelier Creek. One station very near the damsite, designated "Montpelier Creek near Montpelier", was operated from November, 1939 through December 1944. The other station 3 miles below the damsite and measuring essentially all of the flow from the creek is designated "Montpelier Creek at Irrigators Weir near Montpelier" and has been in operation since December, 1942.

Local Flood Reports

There are reports of flooding in Montpelier in 1962, 1950, 1948, 1943, 1955, 1963, and 1952; but there are little data to indicate the magnitude of each. Some of the floods came from rapid snowmelt on the low elevation area below the gaging station and parts of the floods which passed the gaging station were diverted around the city through the irrigation canals so the quantities of flow which caused the damage are not known. The floods are listed above in decending order to indicate their relative severity.

Investigations

Streamflow Characteristics

The 20 years flow record of Montpelier Creek at Irrigators Weir was examined to determine the general nature of the stream and its peak flow frequency

and runoff-frequency relationships. Montpelier Creek was found to be a snowmelt stream whose annual run-off depends upon the quantity of water in the winter snowpack and whose time of run-off depends upon the regional air temperature. Essentially all of each winter's snow moisture runs off during the succeeding summer and a small, relatively uniform amount is discharged during the winter months. There is close relationship between the annual volume of run-off and the annual peak flow. Approximately 90% of the peak flows occur during May and the remaining 10% of the peaks are divided approximately evenly between April and June. There is no relationship between the time of the annual peak flow and the magnitude of the peak, however. The peak flow-frequency and runoff-frequency relationships as determined by methods set forth in Section 3.18 of the Hydrology Guide are summarized as follows:

Percent chance of equal or greater	1%	20%	50%	80%
Flood peak at irrigators weir (cfs)	315	145	93	60
Annual runoff at weir (ac. ft.)	32,000	19,000	14,000	10,500

By comparing the records of the two gaging stations during 21 months of the concurrent operation it was found that 75% of the run-off which passes Irrigators Weir comes from above the damsite and that 85% of each peak flow comes from above the damsite. The time of concurrent operation included one season of low flows and one season of high flows, so the above relationships seem quite certain.

The distribution of run-off by months for the 80% chance year was determined by averaging the monthly run-off pattern of four years whose chance of exceedence was near 80%. The computed 80% chance water supply is as follows:

Month	Runoff at weir (ac. ft.)	Runoff at damsite (ac. ft.)	Runoff below damsite (ac. ft.)
January	430	320	110
February	360	265	95
March	480	350	130
April	1,310	975	335
May	2,050	1,520	530
June	2,110	1,570	540
July	1,070	805	265
August	640	475	165
September	500	370	130
October	600	445	155
November	510	375	135
December	440	330	110

By computations described under "Agricultural Water Management", the irrigation demand for each month was determined and compared with the 80% chance monthly water supply to determine the volume of storage needed to hold water from the early run-off for irrigation in the latter part of the season. It was found that 3,840 acre feet of capacity are needed to fully utilize the 80% chance yield and this will furnish a full season water supply for 3,400 acres.

Evaporation

Evaporation at the reservoir site was computed from data taken at Lifton. Wind movement and temperature accounted for most of the variability of evaporation at Lifton and their effect was determined by graphical correlation. The mean monthly temperature at Montpelier was transferred to the reservoir site by the lapse rate of 5.4° per 1,000 feet and the monthly wind movement at the reservoir site was estimated from observations by local people. Lake evaporation at the reservoir site was computed to be 29.5 inches per year which compares with 35 inches per year as reported for Lifton in U. S. Geological Survey Professional Paper 272-D. This lower amount is attributed to the higher elevation and lower wind movement.

Flood Control

The maximum flood control effect of the 3,840 acre feet of storage was determined by examining the daily flow record of four representative years to find the least continuous flows that could have been maintained by storing the excess in the reservoir. The minimum controlled flow is compared in the following table with the computed natural peaks and the probable controlled flow which can be expected under operating conditions.

Percent Chance (%)	Natural Peak (cfs)	Minimum Peak (cfs)	Practical Peak (cfs)
1	315	150	180
5	220	99	119
10	181	78	94
20	145	57	68

It is estimated that the actual maximum flood flow can be held within 20% of the theoretical maximum flood flow by using snow survey flow forecasts to set the outflow rate at the start of the season and by adjusting the outflow rate as the season progresses. Operating the reservoir for flood control will be critical in 1 season out of 10 and it will be unimportant in 1 out of 3 seasons when the snowpack is light.

Operating the Reservoir by Forecast Data

The run-off of Montpelier Creek can be forecast with sufficient accuracy that the proposed reservoir can be operated for both flood control and irrigation.

When the reservoir must be operated primarily for flood control, the need is apparent from the snow pack on the mountains which represents the run-off potential. This potential can be recognized early enough in the year that any hold-over storage can be released in time to control the flood. The need to operate primarily for irrigation storage is also easily recognized early enough to safeguard the existing supply.

The run-off in years of intermediate supply can be forecast with sufficient accuracy to provide both flood control and irrigation.

The following system of operating the reservoir was developed and by trial use with thirteen years of forecast and flow records it was found to be satisfactory.

- Step 1. Forecast the seasonal (April through September) run-off from snow survey and valley precipitation data.
- Step 2. Break the seasonal run-off into monthly run-off by the average run-off distribution pattern: April 21%, May 33%, June 22%, July 11.4%, August 7%, and September 5.6%.
- Step 3. Break each monthly run-off into the portions which can be expected from above the damsite and from below the damsite. A separate study showed that almost exactly 75% of the run-off at Irrigators Weir comes from above the damsite.
- Step 4. Compute the probable range of run-off for each of the three principal run-off months: April \pm 70% of forecast; May and June \pm 50% of forecast. This usually needs to be done only for run-off at the weir.
- Step 5. Tabulate the anticipated monthly irrigation diversion demand.
- Step 6. Compute the monthly volumes which are available for irrigation from below the reservoir, from streamflow above the reservoir, and the monthly volumes which must be withdrawn from storage to meet the diversion demand.
- Step 7. Compute the quantity of water available for storage. This is the run-off at the reservoir minus the irrigation demand from streamflow above the reservoir.
- Step 8. Determine the seasonal reservoir operation schedule which will provide both irrigation and flood control. Flood control to some important degree is needed when the seasonal run-off at the weir is 12,000 acre feet or greater. This run-off occurs in approximately 2 years out of 3. The computed range of runoff in the first 3 months will indicate the need for flood control and the releases can be planned accordingly. It should be remembered that 90% of the annual peak flows occur in May and if a large peak is anticipated a large portion of the storage should be reserved to store enough of the peak to avoid flooding. The other 10% of the peaks are divided almost equally between April and June and provision should be made for controlling them. The April peak can be controlled by setting the outlet gate to release a safe flow so that any excess will be automatically stored. Some storage should be reserved for a possible peak in June whenever a high flow seems possible.

Irrigation water supply storage is programmed in a manner similar to flood control storage and it is considered with flood control in the years of intermediate run-off when both functions are important. The computed probable minimum run-off volumes are considered and provisions are made to have the reservoir full when the threat of flooding has passed. In the years of low run-off (less than 12,000 acre feet from April 1 to September 30) the reservoir may be filled as early as possible to be sure of having enough irrigation water.

Thus the operation schedule can be made up as soon as the forecast data are available and the actual operation can begin. If a flood year is forecast, emptying of the reservoir may begin at once. (In extremely high run-off years the reservoir would probably have been drained in response to earlier forecasts).

The actual operation can usually follow the forecast quite closely without serious consequences, but the operation can be improved in almost every year by adjusting on the basis of subsequent forecasts.

Structural Design Hydrographs

The reservoir design hydrographs were developed by methods described in Section 3.21 of the Hydrology Guide according to criteria set forth in Engineering Memo 27 as amended. The structure is judged to be in the "c" hazard class and the antecedent moisture condition is "II". The composite curve number for the area above the reservoir is 63 for present conditions and 61 for project conditions as determined from a detailed watershed survey made by the Forest Service.

Winter Flooding

The characteristics of the winter flood events were determined by an adaptation of snowmelt methods presented in Section 3.11 of the Hydrology Guide. The climatological records of the months of January, February, and March for the years 1950 thru 1963 were examined to determine (1) the greatest accumulation of snow moisture, (2) the greatest single degree day, and (3) the greatest daily snowmelt-plus-rain. The melt rates were estimated from information in U. S. Corps of Engineers Summary of Snow Hydrology, 1956. The probability of having densely frozen soil was also estimated from climatological data. Combined October and November precipitation seemed to be the best indicator of frost density because moist soil is required to form low-permeability frost. Comparison of maximum daily snowmelt-plus-rain, antecedent moisture, and reported winter flooding indicated that frost dense enough to cause flooding from a fast melt occurs in approximately 6 years out of 10. The antecedent moisture condition was taken as being independent of the daily melt plus rain and the two probabilities were multiplied to arrive at the 1% chance melt-plus-rain which was used to synthesize hydrographs for the flood control measures which are proposed to be built near the city. The 1% chance melt-plus-rain was found to be 1.5 inches and for hydrograph purposes it was assumed that 0.9 inches of rain fell in 6 hours distributed as indicated on curve "B" of Section 3.21 of the Hydrology Guide. The 0.6 inches of snowmelt was assumed to have melted at a uniform rate of 0.1 inches per hour so that the composite storm covers six hours.

The runoff curve number for the frozen soil was deduced by a reverse application of procedures in Section 3.10 of the Hydrology Guide. The peak flows were estimated from concordant flow studies of the February, 1962 and February, 1963 floods; the time to peak (T_p) was estimated from drainage area topography; the volume of runoff was estimated from the relationship $q = \frac{484A0}{T_p}$; and a run-off curve was selected which matched the computed run-off with the design precipitation. Hydrographs for the various structure sites were then synthesized by procedures of Hydrology Guide Section 3.21 and were routed through the proposed structures.

Economics

Three interrelated problems of land and water management exist in the Montpelier Watershed, (1) the frequent occurrence of damaging floods originating from two unrelated sources, the frontal area just east of the cultivated lands, and the main drainage of Montpelier Creek; (2) a shortage of irrigation water during the latter part of the irrigation season; and (3) a need for drainage facilities to lower the water table on some of the low-lying land early in the growing season.

In some instances all three problems affect the same areas. Because of the interrelated nature of the problems, the full realization of the beneficial effects desired by the sponsors is dependent on the installation of all proposed measures.

Flood Damage Appraisal

The floodwater and sediment damage to crops, pasture and agricultural properties was estimated in group meetings with farm owners and operators of 90% of the agricultural damage area. The area flooded in February and again in April 1962 was outlined on a map. The farm operators also provided information on areas inundated by other floods which assisted in establishing the frequency of these events. The amount of damage to crops and pasture was estimated. Also, estimates of the increased production which would result from supplemental late season irrigation water was determined.

The effect of frost on crop yields resulting from late seeding in the spring following floods was estimated and incorporated into the analysis.

At the meetings cost and return estimates were developed for various crops for yield levels under present conditions of flooding and high water table, and under improved conditions with program measures installed.

Flood damage to agricultural areas other than crops and pasture was obtained by interviewing farm owners and operators and enumerating the damages resulting from the 1962 floods.

The damage from floodwater and sediment to the urban and commercial properties in the town of Montpelier was appraised by interviewing people who had knowledge of the flooding which had occurred over the past 20 years. Particular attention was given to the floods of February and April 1962 and other floods which had occurred in May 1952, April 1950, May 1948, and June 1943. This data served as a basis for establishing the annual rate of flood damage to the town.

Interviews established an exceptionally high rate of indirect damages associated with the floods in the town of Montpelier. Flood flows overtop the creek channels and spread over streets, under homes and into basements. Normal business activities are interrupted. Frequently the value of the indirect damages exceed the amount of direct damages. In the urban and commercial areas of Montpelier indirect damage was estimated to equal 24% of the direct damage, while in the agricultural areas the indirect damage was found to equal 10% of the direct agricultural damages.

The damage appraisal considered increased crop damage which would result from higher crop yield projected to occur from the adoption of improved technology over the next 25 years. The application of irrigation water by sprinkler systems on 625 acres of floodplain lands was considered in this projection.

Damage estimates were adjusted to long term price levels in accordance with "Agricultural Price and Cost Projections", September 1957; U. S. Department of Agriculture.

The average annual floodwater and sediment damage to the agricultural areas and urban and commercial properties was established by developing a damage-frequency curve.

Irrigation

The need for additional late season irrigation water was calculated by inventorying the irrigated crops under present conditions and determining when the present water supply furnished by direct flow from Montpelier Creek would no longer meet the water requirements in the area. The amount of supplemental water needed was established for each crop by the Blaney-Criddle method. The benefit from the supplemental water was determined by estimating the difference in net income for each crop as experienced under present conditions of short water supply and the expected income anticipated for a full season supply. The estimated yields under various conditions were estimated with the assistance of farmers and agricultural technicians who had a good knowledge of the agricultural production in the area.

Improved methods of irrigation will be applied to the irrigated land. It is anticipated that approximately 1,000 acres will be irrigated by sprinkler systems. The annual cost of these land treatment measures for improved agricultural water management will equal \$31,200 per year. This amount was deducted as associated cost in the budget analysis from the income expected after installation of the project to determine the benefits which will accrue to the irrigation features of the project.

The rate at which farmers will install improved crop rotations, improved agricultural water management, and other beneficial practices will depend upon an education program and the capital limitation of land owner and operator. The lag in the realization of benefits made possible by reduced flood hazard, increased water supply and improved drainage conditions was estimated to be 25 years. The agricultural water management benefits were discounted for this period to determine present values.

The following tabulation shows the net income value of the crops produced with and without the project, which served as the basis for determining the benefits from the agricultural water management phases of the project.

Summary of Net Income by Evaluation Areas

Cultural and Managerial Areas	Without Project Condition 25 Yrs. Hence	Present Condition	Project Condition	Project Condition 25 Years Hence
Surface irrig. area	\$15,178	\$15,178	\$52,393	\$82,823
Sub-irrig. area	11,390	11,390	11,609	18,413
Sprinkler irrig. area	35,822	20,479	20,642	51,980
Misc. or odd areas	<u>2,348</u>	<u>2,348</u>	<u>2,348</u>	<u>2,348</u>
Total	\$64,738	\$49,395	\$86,992	\$155,564

Incidental Recreation

Recreation is not a planned part of this project but due to the impoundment of water for late season irrigation purposes and the dead storage needed for sediment accumulation, there will be an enhancement to all water oriented activities in the watershed. Fishing is by far the most important water-oriented activity in the watershed. Boating, swimming, and water skiing will also be affected to a lesser degree. For this reason only the incidental recreation benefits from the increased fishing opportunities have been evaluated.

The increased fishing opportunities from the impoundment of water by the reservoir has been evaluated with the assistance of other federal and state agencies. The following steps were used in the evaluation determination:

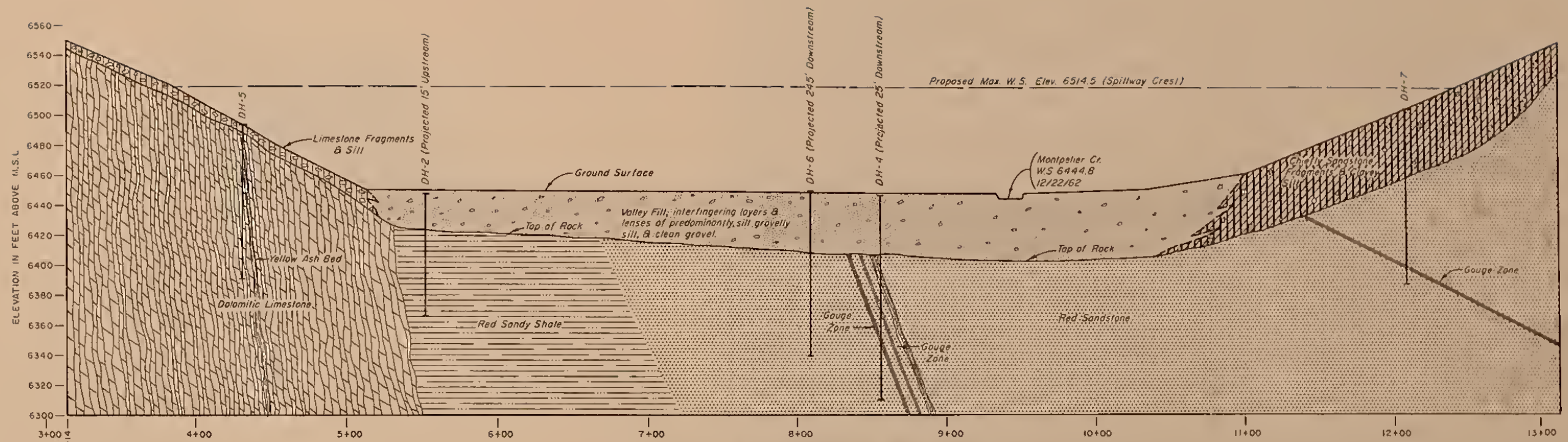
1. The average annual surface area in acres was determined for the main recreational season (May through August).
2. The present estimated fisherman trips per surface acre was determined for the main recreational season from similar usage of impounded waters in the area to equal 20 annually.
3. The average annual surface area during the primary recreational season was multiplied by the estimated fisherman trips per surface acre to determine total present usage as if the reservoir presently existed.
4. Established a projection factor of 2.82 times present usage for the average annual fishermen trips over the life on the project on the basis of the human population increase in the area and tourist use of the project pool.
5. Multiplied step 3 by step 4 to determine the average annual fishermen trips over the life of the project.

6. Established a value of \$1.50 per fisherman trip due to the excellent fishing found in the area and the extremely heavy fishing pressures the area is now receiving.

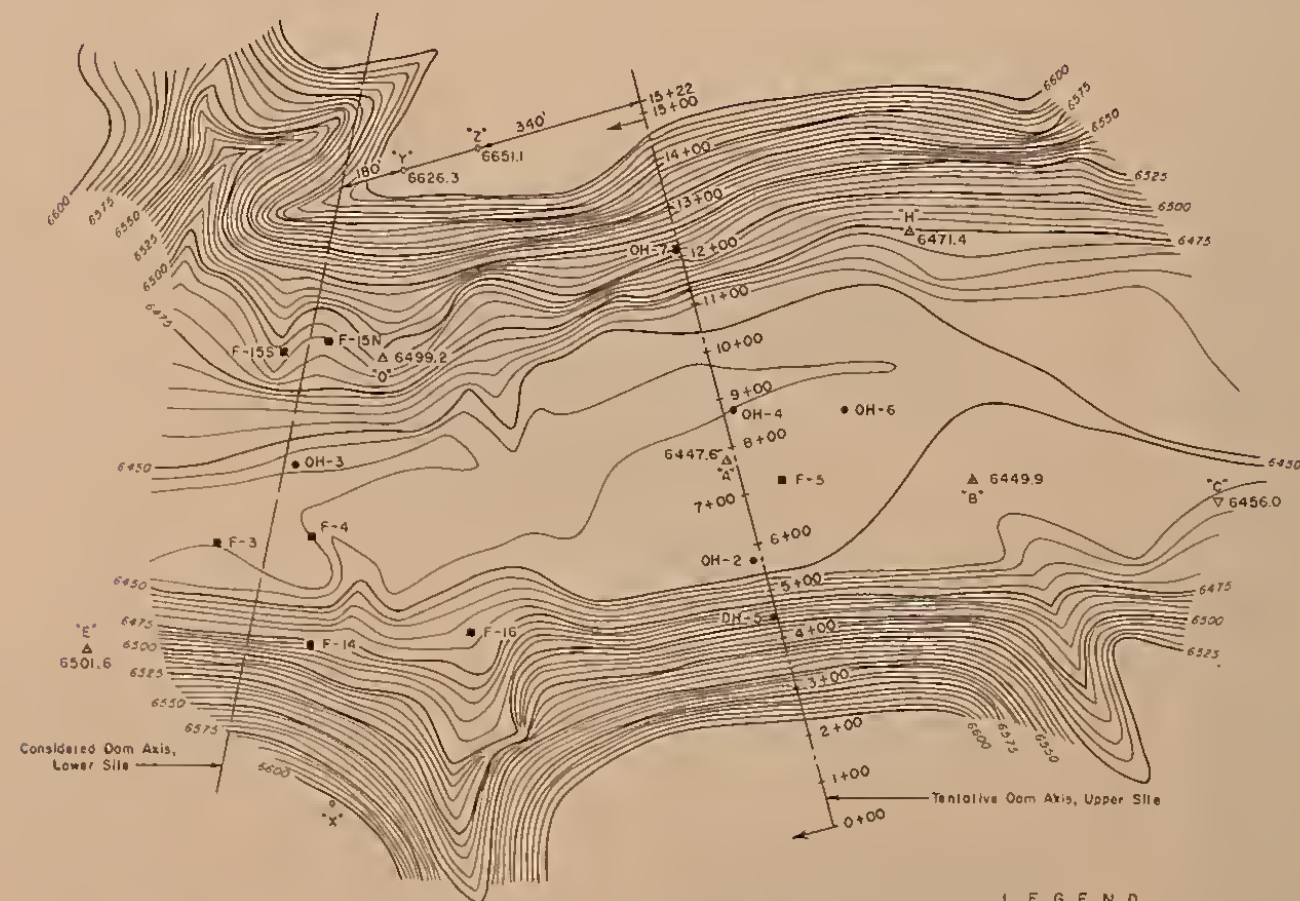
7. Multiplied step 5 by step 6 to determine the gross average annual incidental recreation benefit from the impounded water behind the reservoir.

8. Deducted out the associated cost of stocking the reservoir to obtain the net incidental recreation benefit.

In step 2 of the evaluation of incidental recreation benefits the estimated fisherman trips per surface acre was determined from similar usage of impounded waters in the area without recreation facilities such as the Forest Service plans to install under their going program. It is felt there will be additional usage of the reservoir area and Montpelier Creek itself to more than offset the costs of the recreation facilities planned by the Forest Service. For this reason they have not been included in the benefit cost analysis but rather treated the same as any other land treatment measure of the Forest Service.



GENERALIZED GEOLOGIC SECTION



PLAN

200 0 200 400
SCALE IN FEET
CONTOUR INTERVAL = 5'

LEGEND

- OH-4 Drill Hole
- F-5 Foundation Test Pit
- Line of Geologic Section

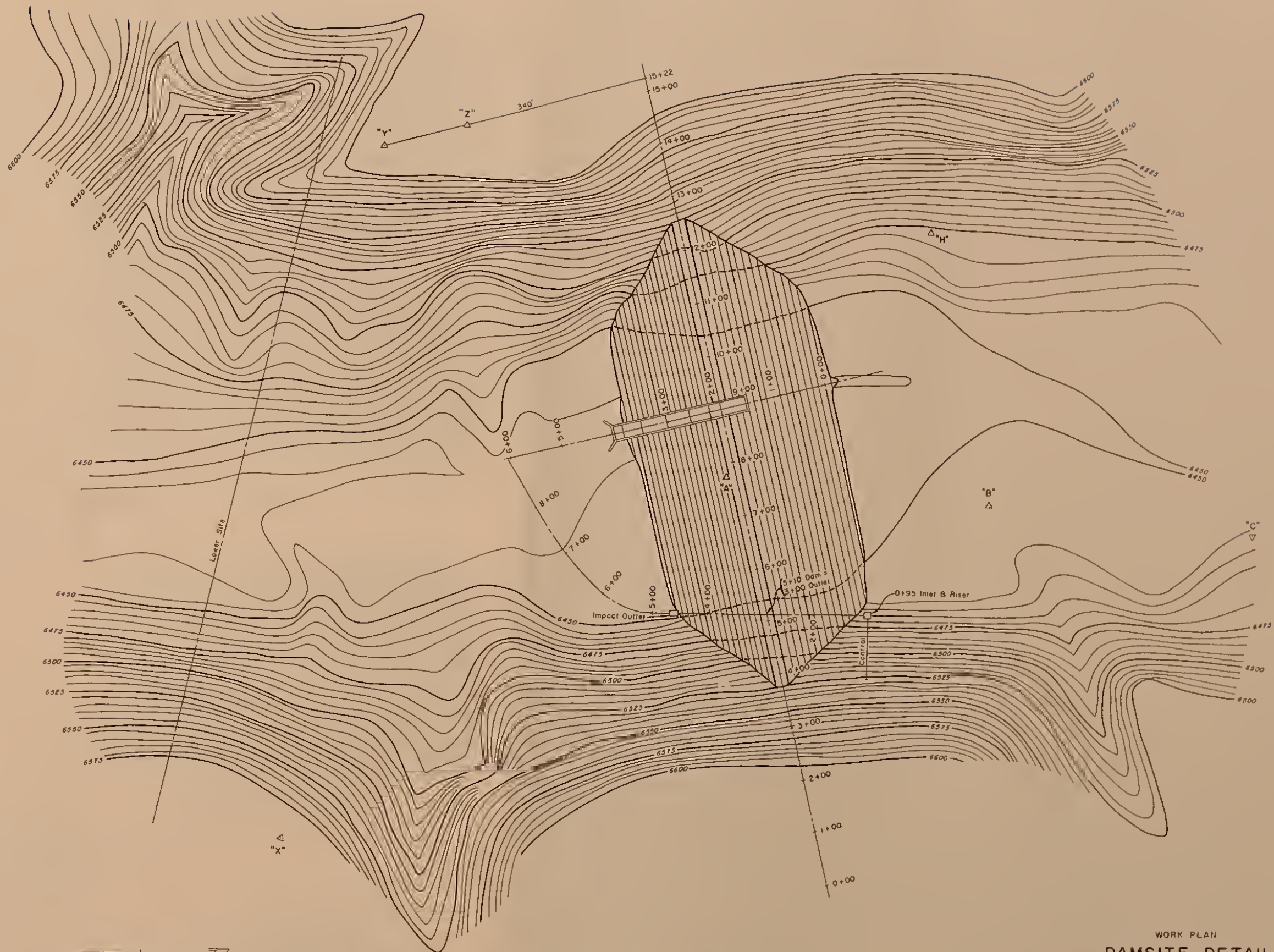
NOTES:

- 1 Section compiled from exploratory drilling & surface geology; dashed lines indicate inferred position.
- 2 Rock strata strikes N. 12° W. approx. perpendicular to line of geologic section; line of section roughly parallels true dip of strata.
- 3 Beds are overturned to east towards left of section
- 4 Section is drawn looking downstream & shows drill hole locations along dam axis.

WORK PLAN
GEOLOGY-UPPER DAMSITE
MONTPELIER CREEK WATERSHED
BEAR LAKE COUNTY, IDAHO
PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by M.H.A. Date 2/64 Orig. No. 7-E-17711
Sheet 1 of 5 Sheets



PLAN

100 0 100 200

SCALE IN FEET

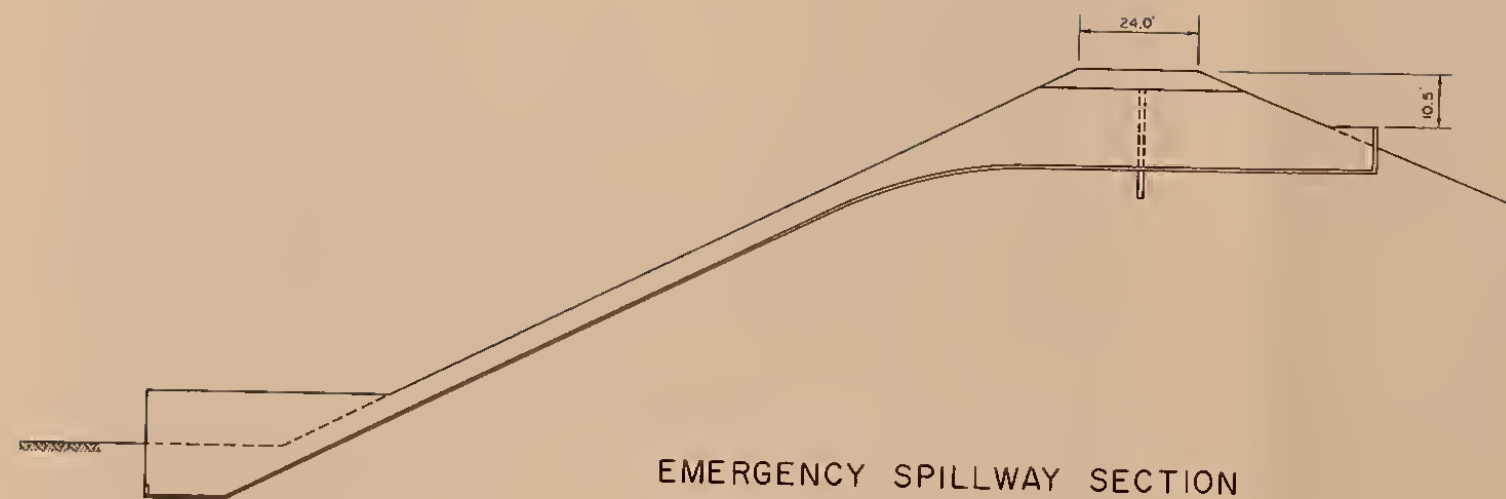
CONTOUR INTERVAL = 5'

Datum: Mean Sea Level

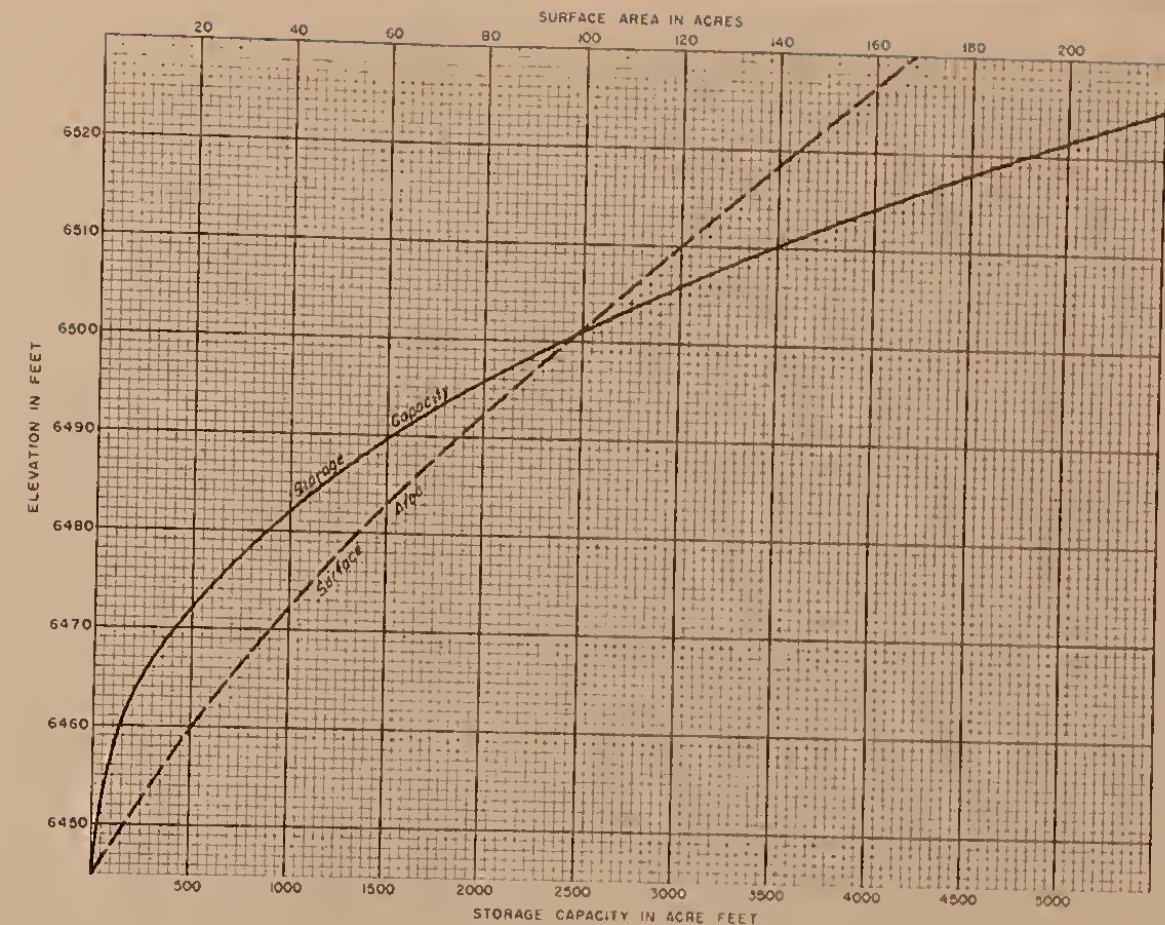
WORK PLAN DAM SITE DETAIL MONTPELIER CREEK WATERSHED BEAR LAKE COUNTY, IDAHO PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

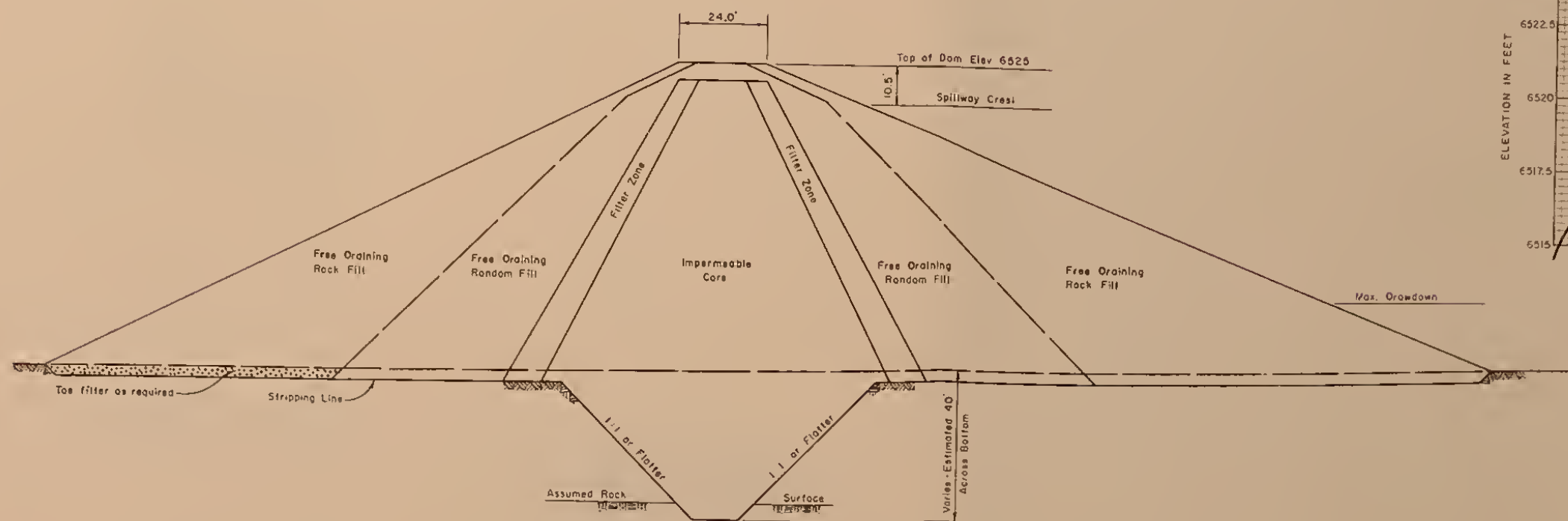
Prepared by W.Q.B. Date 1/64 Orig No 7-E-17711
Sheet 2 of 5 Sheets



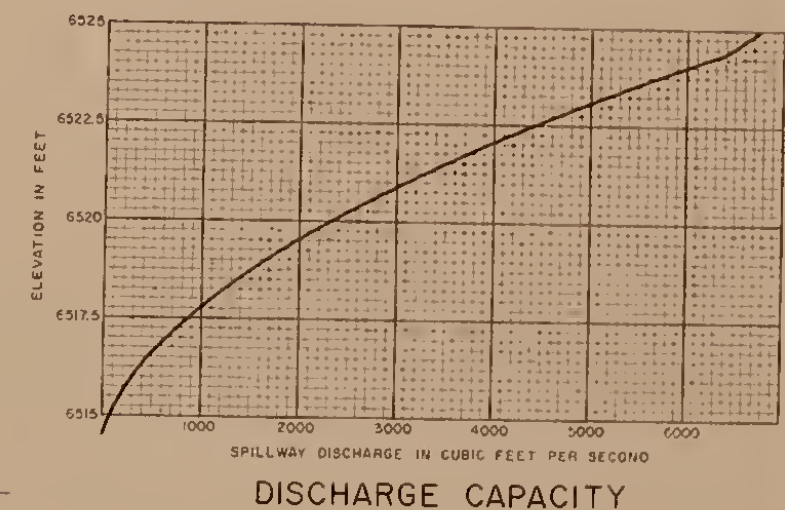
EMERGENCY SPILLWAY SECTION



AREA CAPACITY CURVE



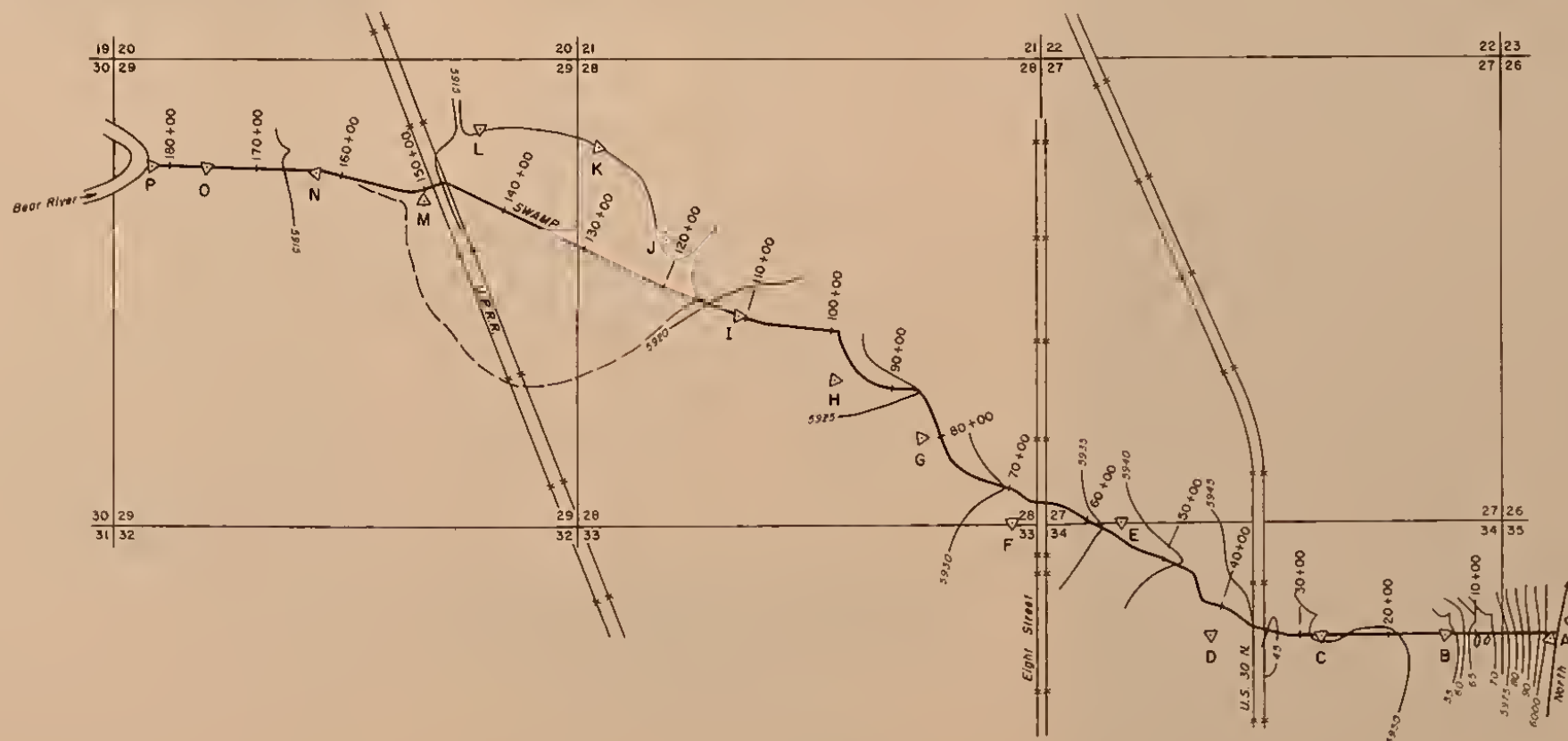
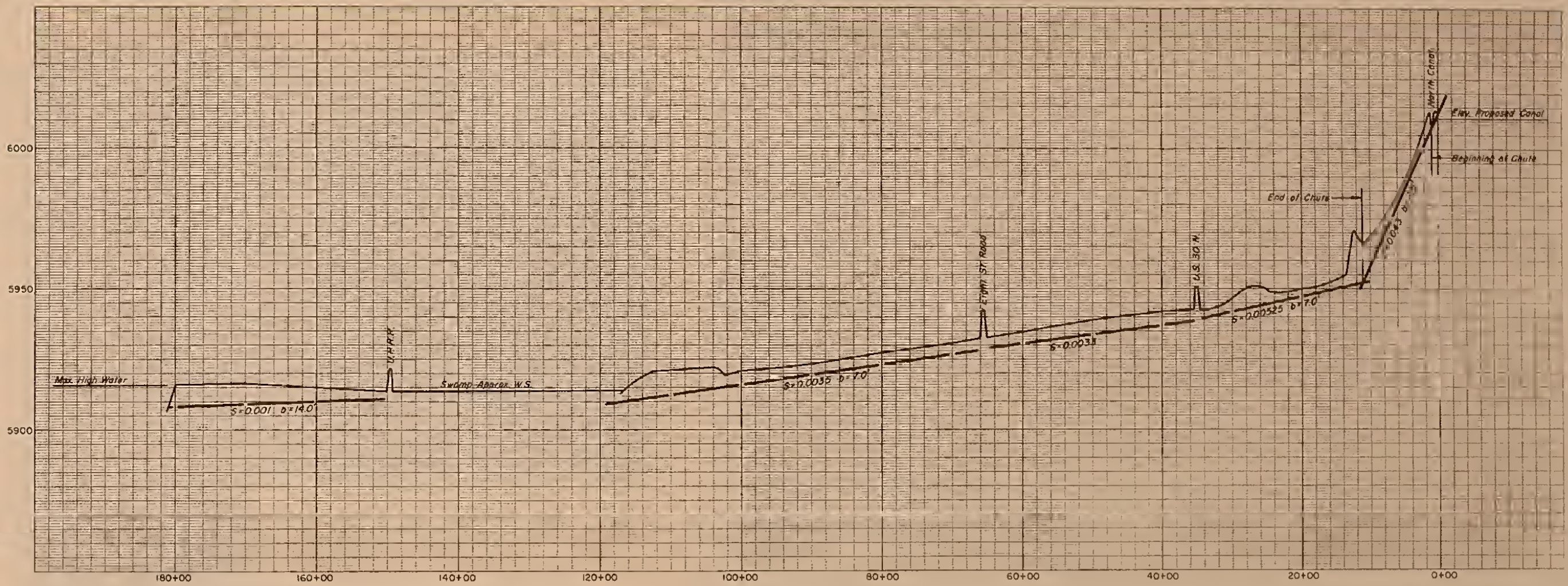
TYPICAL ZONED FILL SECTION



DISCHARGE CAPACITY

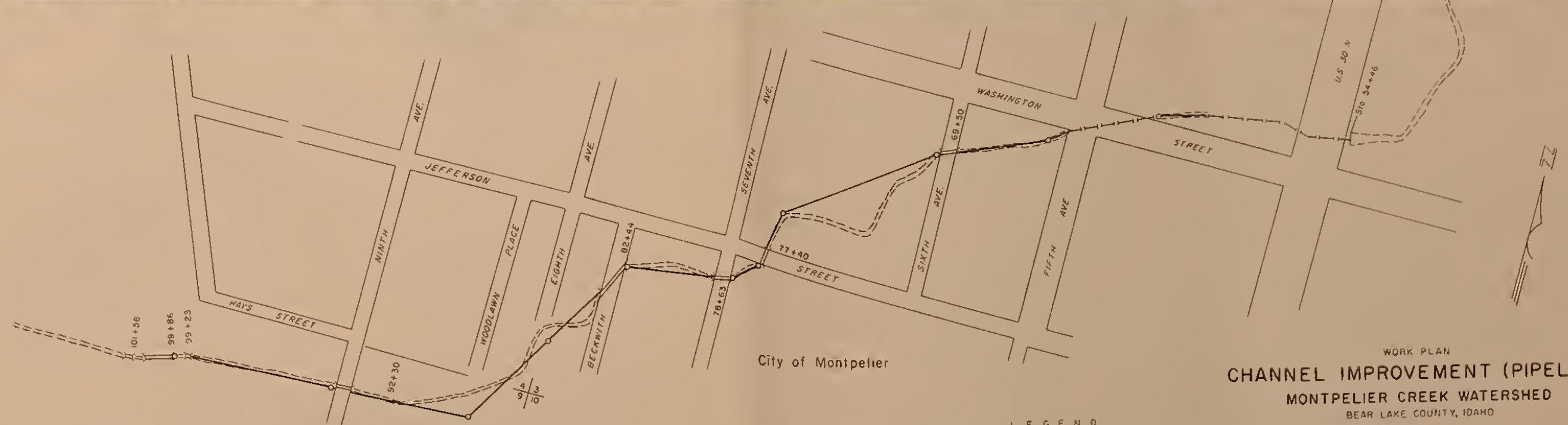
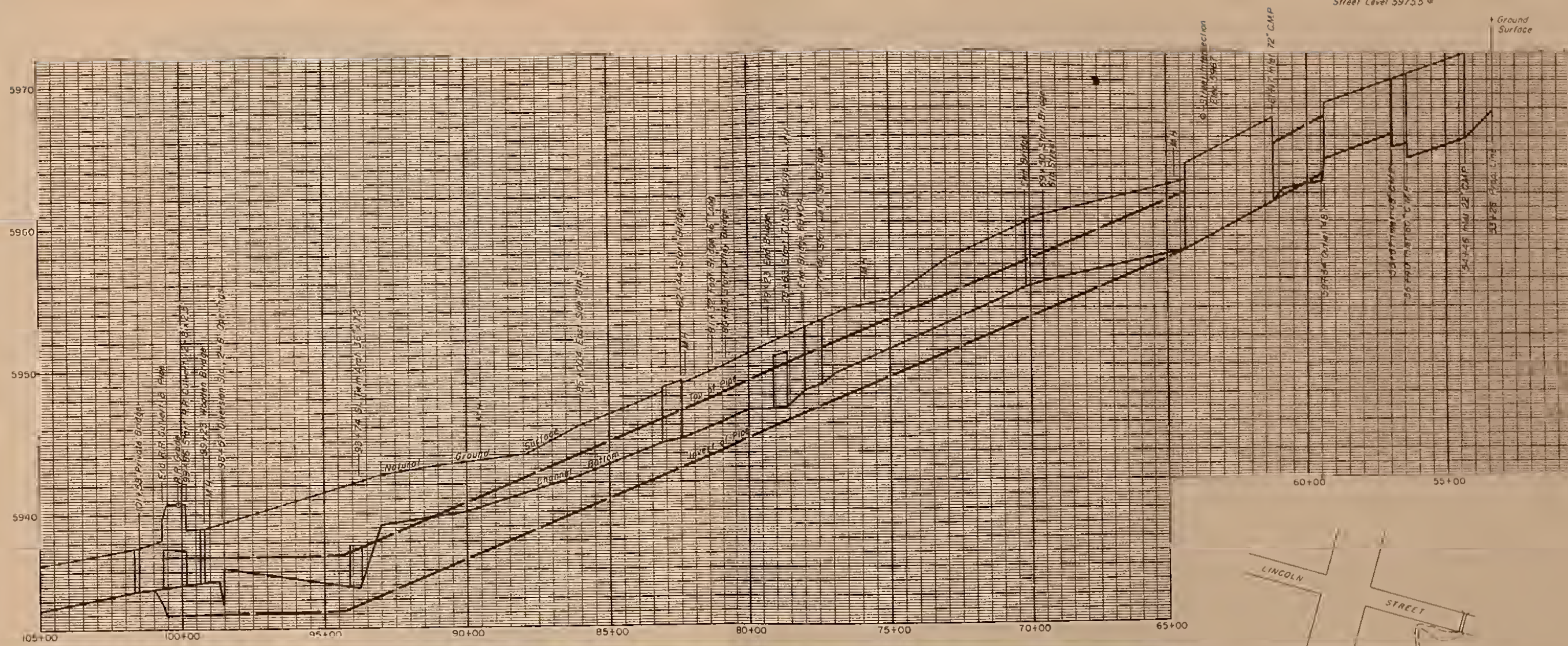
WORK PLAN
DAM DETAILS
MONTPELIER CREEK WATERSHED
BEAR LAKE COUNTY, IDAHO
PRELIMINARY PLANS

U S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



WORK PLAN
NORTH DRAIN
 MONTPELIER CREEK WATERSHED
 BEAR LAKE COUNTY, IDAHO
PRELIMINARY PLANS
 U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by W.D.B. Date 2/64 Draw. No. 7-E-17711
 Sheet 4 of 5 Sheets



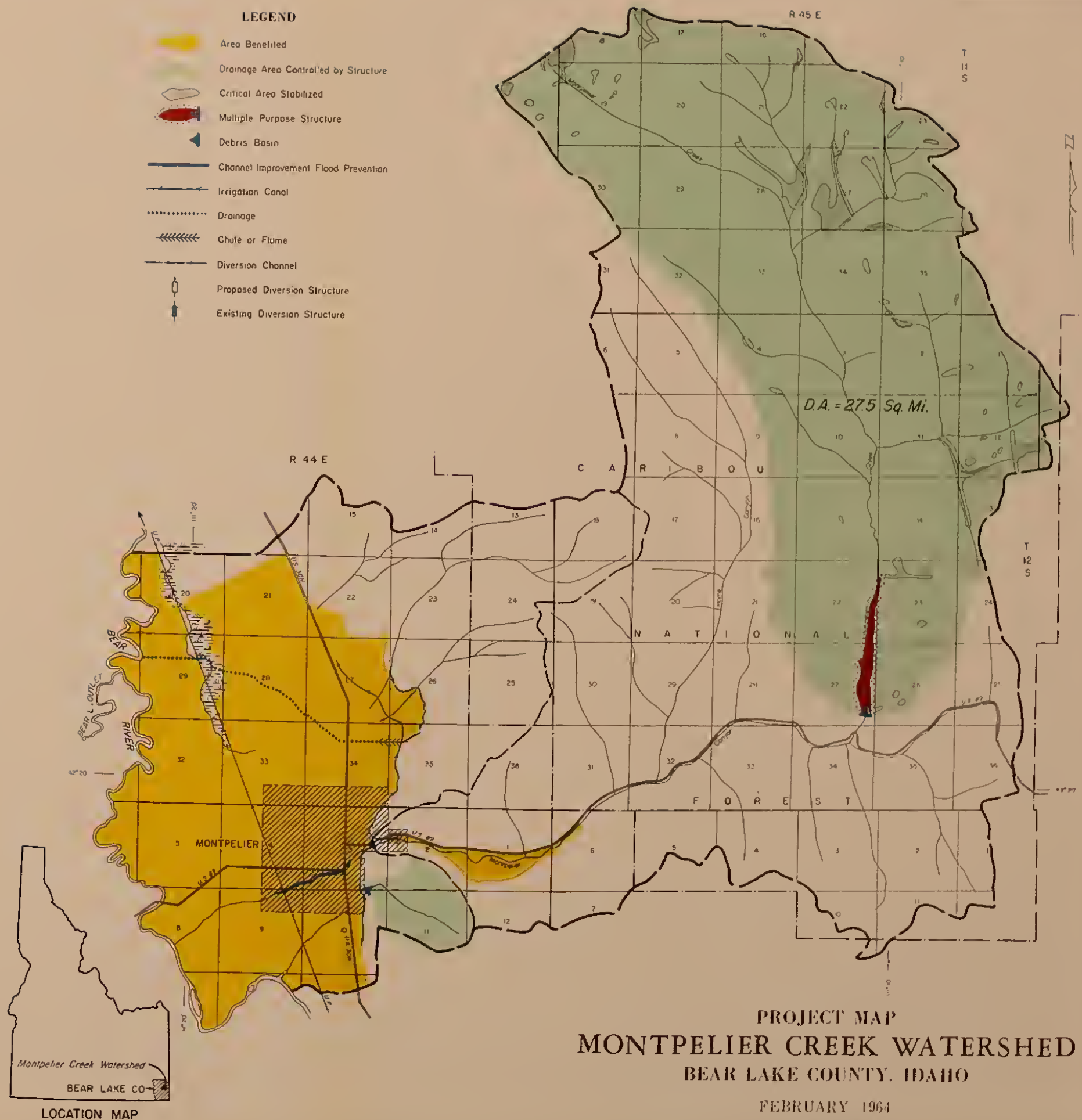
WORK PLAN
CHANNEL IMPROVEMENT (PIPELINE)
 MONTPELIER CREEK WATERSHED
 BEAR LAKE COUNTY, IDAHO
PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

- LEGEND**
- Proposed Pipeline
 - - - Existing Pipeline

Prepared by W.B. Date 2/64 Orig No **7-E-17711**
 Sheet 3 of 5 Sheets

	Area Benefited
	Drainage Area Controlled by Structure
	Critical Area Stabilized
	Multiple Purpose Structure
	Debris Basin
	Channel Improvement Flood Prevention
	Irrigation Canal
	Drainage
	Chute or Flume
	Diversion Channel
	Proposed Diversion Structure
	Existing Diversion Structure



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